PRACTICAL
ROWING AND TRAINING

THE SHOOT. Frontispiece. *See page* 24.

(The hands are well started before the body begins to move on the recover.)

PRACTICAL ROWING

WITH SCULL AND SWEEP

BY

esley

ARTHUR W. STEVENS

AND

THE EFFECTS OF TRAINING

BY

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ILLUSTRATED FROM PHOTOGRAPHS

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CONTENTS

THE EFFECTS OF TRAINING

LIST OF ILLUSTRATIONS

PRACTICAL ROWING

INTRODUCTION

TIME may have been when rowing existed only as a means of getting from one place to another on the water, — a time which need not concern the present treatment of the subject, except as it furnishes examples for comparison with the art or, as it has come to be, the sport of rowing to-day.

Rowing very naturally divides itself into two branches; under one head comes Sculling or individual rowing, under the other head Rowing properly so called, collective and organized sweep rowing in pairs, fours, and eights.

Sculling in the single boat or shell presents many opportunities for individual development and form along what may be called the lines of least resistance. In the scull or shell the rower is sole master of his craft and is alone responsible for its movements. I say master of his own boat, for I suppose him to be a sculler. To be sure he has found, for a while at least, that the boat was almost

master of him. Only with practice has come confidence and with skill has come individuality of style. As men vary in physical development, so their style of sculling varies and lends itself to power in one part of the effort of sculling and favors a weaker effort in some other part of the stroke. It is for this reason that there are almost as many styles of sculling as there are scullers; and while one may impart to another the fundamental principles of sculling, the latter's working out of those principles is almost sure, for physical or temperamental reasons, to be at variance with them.

The other form of rowing — the concerted effort of two, four, six, or eight men in a crew — is a much more complicated matter. For obvious reasons I shall consider the eight as the sweep rowing standard. In the eight-oared crew it is necessary to subordinate the individual to the larger crew unit. Therefore we must presently bring ourselves to think and say that the crew *is*, not are, rowing racing, or paddling. This fusing of the individuality of each man into the larger crew unit and the necessary subordination of individual characteristics can be accomplished without loss to those composing the larger unit, provided there is constant emulation and healthy rivalry among the candidates for the crew, and patient, constructive

coaching from an impartial critic. For in a crew it is almost certain that there will be one man who is ideal perhaps in physical strength,—one who in this particular respect is just a little better than any one else. To attain to this condition of strength, or even to surpass it, should be the desire of the other candidates, while to this individual himself a quality of quickness or smoothness displayed by some other associate will appeal constantly, and he in turn will strive for its acquiring.

I. ROWING TERMS

AMONG the traditional and generally accepted terms relating to different parts of the stroke in rowing—terms which have through constant repetition and the "dinning" process come to be apparently mere names—are the words "catch" or "beginning," "finish," "recover," "drive," "reach," "rushing the slide," "following," "shooting" or "tossing the hands away," "hanging," "slumping," "falling over," and other expressions suggestive of the proper and improper methods of performing different parts of the stroke.

To those who have followed rowing, or who have at one time or other rowed and been coached, it will not seem strange that the terms above referred to, often repeated and oftener shouted out to the crew by the coxswain, are set down by many as one of the necessary evils of the sport, a sort of "rigmarole" quite as inevitable as the cold shower that follows the order "Over the heads" from the captain after a sloppy afternoon on the river.

It is quite as true that any humanizing of these expressions, or enlarging upon them, is out of the question at the time when the force of their mean-

ing is most needed, as when the crew is boated and out for a spin, with or without the coach. Few crews desire to spend several minutes shivering through a sermon, and few coaches desire to rehearse generalities the import of which should be in the mind of every man who has any interest or desire to be even reasonably proficient in rowing.

To the end, then, of clothing these "dry bones" of rowing terminology with the garment of their various equivalents let us consider at first the meaning of the words or expressions in their most apparent and natural relations. In this way we shall see that these terms lose their strictly dry and technical aspect to assume a more human and intimate character.

The Catch

Among college men, where sport naturally receives greater attention than is possible elsewhere, a selection of one of the most salient features in the game of baseball will serve as a not unfamiliar example to illustrate one of the first moves in rowing, — the catch.

To the observer, the act of catching a baseball is a perfectly definite one, whatever preparation there may have been before the catch. If the actual catch is not visible, it is usually audible enough to leave no doubt of its being instantaneous. The ele-

ment of gradual acquisition can be left entirely out of account, newspaper accounts of "high flies gathered in" to the contrary notwithstanding. It must be noted that only the act of catching is being considered, and it is seen that, confining ourselves to the act alone, the catch is instantaneous and definite after the preparation has been completed. So, then, to turn to rowing, the catch or beginning of the stroke, the application of power to move the boat forward — the change of direction after the reach — should be sharp, immediate, and snappy. Sharp, so that it may cut in cleanly; immediate, so that it shall lose neither time nor space; and snappy, so that it shall be effective.

Drive

The drive, or leg drive, following immediately after the catch, is a very important part of the stroke. The old rule, "First make sure and then go ahead," might be rewritten, "Make sure of the catch and then drive the stroke through." The idea of drive must not be confused with the landsman's alternative, — ride, — as it is too often by crews. Drive implies an action wherein power is used. The idea of persuasion or coaxing is not present. The drive of the legs in rowing is imperative. The boat is no longer left to herself, but is driven by the man behind the oar. Moreover, the drive must

THE CATCH. *Page* 6.

be steady, not merely a kick or boost. A golfer must be a very "duffer" who is satisfied with a "drive" that sends the ball sputtering two or three yards from the tee. There must be the "follow" to the drive to give it weight and direction. So, in rowing, the position must be firm, the body controlled, and the feet pressing solidly and evenly on the stretcher throughout the drive, — and longer, for the leg drive is ineffective unless it acts on the water by means of the oar. Therefore, the drive in its larger sense is not confined solely to the legs, but is continued by the arms, and becomes, in fact, the very stroke itself.

It would be considered gross negligence on the part of a carpenter if he were to build a house and not drive the nails used in the construction all the way in. We should be obliged to go about completing the work he had left unfinished, or run the risk of catching on projecting nails and injuring ourselves or our clothes. Yet many crews forget to finish one stroke before beginning the next, and in consequence go stumbling from one half-driven stroke to the next, tearing up the water on the recovery, and for no other reason than that they have not driven clean as they went along. It is a mistake to think that quantity is an adequate substitute for quality. One long drive of the oar in the water from catch to finish, a drive which keeps the

water piled up in front of the oar and leaves a chugging puddle behind the blade, is worth two or three half-drives that commence and end in the air and include a momentary jab at the water somewhere in the middle of the stroke.

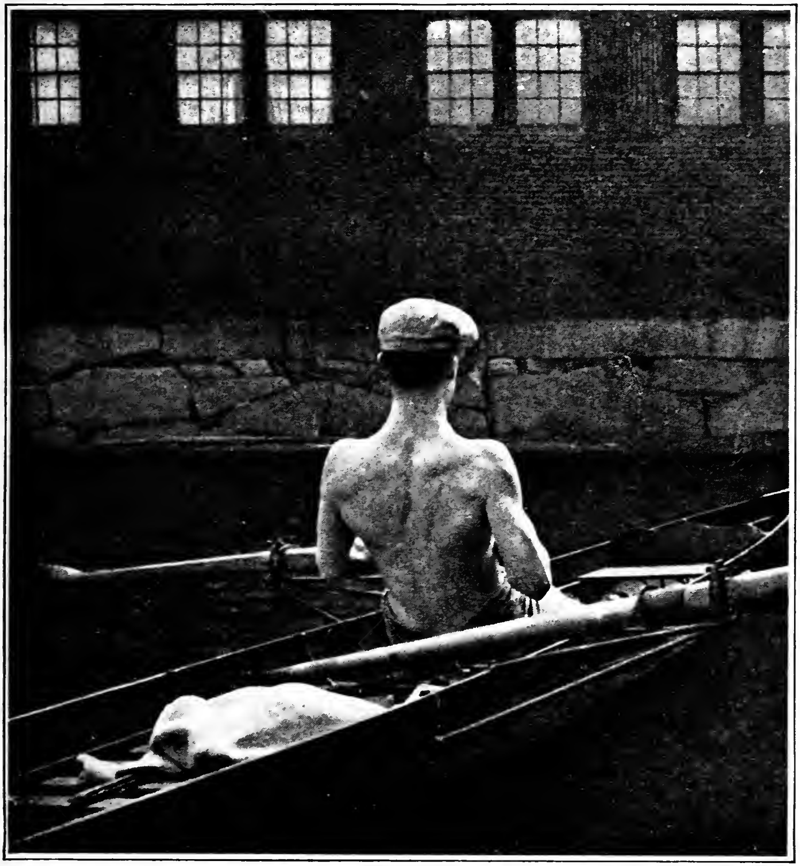
It is not unnatural to regard the leg drive as the most important factor in rowing a boat where a sliding seat admits of the use of the legs in addition to the body and arms. Even here, however, there is a chance that the leg drive will be exaggerated,—yes, will exaggerate itself to the extent of pushing away the slide without necessarily carrying the shoulders with it. To any one who has looked over Dr. D. A. Sargent's strength test charts, the fact that the legs are much stronger than the back must be well known. The legs are naturally the working members, and as such are capable of a greater effort than the complex muscular structure of the back. When, therefore, the leg drive is used in rowing, it is important that it be no harder nor quicker than the back can hold the shoulders up to, or even carry them ahead of, lest the oarsman render himself open to the criticism that he is "biting off more than he can chew." If the legs are driven down and the back is unable to hold the drive, nothing is gained; the back is left behind, and instead of driving everything before it, the legs have only driven the slide. The oar, instead of

being pulled through, has pulled the oarsman back for at least part of the stroke. The leg drive must not catch the body unprepared, but rather find the body anticipating, by the fraction of a second, the getting away, — the getting turned in the new direction, after the recovery as well as after the stroke. For if the body work is to begin and end with the slide movement, the body must start quicker and move faster than the slide, because the slide or point where the body pivots moves in a straight line backwards and forwards, but the shoulders above reach in front of the slide on the full reach and then swing in the arc of a circle to and back of the slide at the finish of the stroke. Evidently, then, the shoulders and what controls them — namely, the muscles of the back and the pectoral muscles in front — must contrive to move the body faster than the slide because the body has further to go in the same length of time. If it must move faster, it must start quicker. The quick overcoming of the inertia of the body, and the momentum imparted to it, serves to act to the legs as a balance-wheel does to an engine; for if the body can be started back simultaneously, or possibly just before the legs start their drive, its weight and its acquired momentum, coupled with the effort of the back muscles, can hold the hardest drive the legs are capable of, and for as long a time. Let the legs

start just the smallest interval before the back is ready and the back has the well-nigh impossible task of overtaking the legs.

The Finish

Another point that deserves attention is the end, or finish, of the stroke. The end of anything is still the thing itself, and not something else. So with the end, or finish, of the stroke. It is not a part of the recovery, nor should it in any way anticipate the recovery. In this instance I am considering the motion of the blade in the water, and am presuming the balance to be even. If the finish is part of the stroke, then it must be governed by the rules which govern the stroke. The most obvious of these is that it must be in the water. It shares with the catch the quality of being instantaneous, — more so, if possible, than the beginning,— for the reason that at the finish the boat is moving faster, and the blade must be taken out more sharply if it is to avoid pulling the boat off keel. The finish may be the weakest part of the stroke, because while we had both the strength of the legs and that of the back combined in the first and middle parts of the stroke, the finish must be left to the arms almost entirely. It must be remembered, however, that the value of the arms is hardly less than the combined legs and back, for it was for



Rear View of Position at the Finish. Elbows down.
Page 10.

them to start or pick up the boat, and then, having given the push, to leave the adjustment of balance, and the now comparatively easy task of carrying the constant pressure of the blade in the water, through to the end to the quicker moving arms. It is much easier to keep the boat moving after it has been started than to set it in motion, so that, while the arms may not compare favorably in strength with the combined effort of legs and back, their actual value is fully as great, if not greater; for it is for the arms not only to finish up what has been started by the mechanical movement of legs and back, but also to reduce and adapt the mechanical movement to the requirements of balance.

To get the full value of the arms in finishing the stroke, the elbows should be kept down by the body, and not lifted out and away from it. This rule should be particularly observed with respect to the outside arm,—that is, the arm nearest the end of the oar handle,—in order that the power may be applied or continued at right angles to the oar and in the line of the forearm. In other words, it must be remembered that in speaking of pulling an oar, the word "pull" is meant, not "push," nor "let go," as the end of the stroke comes round. If the outside arm consisted of an upper arm, while for the forearm and hand a strap and hook were

substituted, the value of this now miscellaneously composed member would not be perceptibly lessened as far as rowing is concerned. If it is borne in mind, then, that the outside hand should hook around at the end of the oar handle, and that the angle between the oar and the forearm should be maintained as near ninety degrees as possible, so that the hook can always pull and not be too busy holding, clinging, or climbing round the end of the oar (perhaps so as not to bump into the body), and not tend to slip off entirely and so miss being in at the finish, the elbows will come in naturally by the side, and the pull will be maintained as it was started — to the finish of the stroke.

Recover

The object of the recover, — or means to that end, the reach, — must be kept in view, but the recover itself must also be considered. A full understanding of the means will make the acquiring of the end more accurate. The recover might be called a prolonged dead-center in the stroke. It is the time when what has been done must, according as it has been well or ill completed, carry the boat along and balance her at the same time. It is during this period that the crew must try to steal a march on its own boat by getting from its position at the finish of one stroke out again to a

position of readiness for the next stroke without disturbing equilibrium or retarding speed.

Few crews find balance to be an inherent quality in the boats they row, nor do they find that during the recover their boats will acquire on-keelness that has not been given and left with them at the end of the previous stroke. A shell eight is manifestly top-heavy; and while it can be rowed along after a fashion on one side or the other, when the attempt is made to get ready for another stroke and the oars are withdrawn from the water and what little support there was is removed, the boat lurches to one side and a clean recover is impossible. On the other hand, if the boat has been carried through the stroke on an even keel and the power is taken off simultaneously by both sides finishing together, and moreover if the oars are lifted out in unison, there is no choice on which side the boat shall fall, and, aided by the steadying oars, she hangs in the balance. While she thus hangs, the crew steals out to the next stroke. In using the expression "steal a march," the simile, in so far as it suggests the skilful and careful control of the motions of the crew as distinguished from blundering haste with its scuffle of oar blades, applies to a less strenuous sort of rowing, though it may be said to underlie any form of rowing in shell boats. For the most part, however, where rowing practice looks toward

racing, the oarsmen must assume a more frankly aggressive position and must acquire, actively, the control over their boat.

This brings us to the consideration of the values of inertias in an eight-oared crew in their relation to the recover. An average eight-oar crew will weigh rather more than three times its steersman, boat, and oars' weight. It is important that this excess of weight, this inertia, contribute not only to momentum, but also to balance. The oars may, and unquestionably do, contribute much to balance; but it can be easily seen that, with a cross wind, the oars on the side from which the wind is blowing will tend to unbalance the boat more than the opposite oars can tend to balance. It is in such cases that the inertia of the crew should be directed toward holding the boat from rolling. This can be accomplished only by forcing the inertia of the crew into the boat through the feet and stretcher, since these are the only fixed points of contact. That this is intended in present-day rowing appears from the fact that the feet are held in the stretchers as in a sandal. More, they are held, one on one side and one on the other side of the keel, thus making adjustment of balance possible by varying the pressure, or lift, with one foot or the other on or from the stretcher during the recover, and for the same reason that the oars balance the boat.

The oars, by their length, act as balancing poles or long levers, while the diminished length of the lever on which the feet act is in some measure compensated by the weight or force exerted through that short lever. The toe straps, as they are called, are to the recover what the stretcher is to the stroke. They give the rower as firm a hold on the boat from within and as much control as he has a mind to exercise.

When favorable conditions of weather prevail and when a crew gets its bearings, its swing or beat, and above all, its watermanship, this use of the toe straps throughout the recover becomes less necessary, and is scarcely more used than to bring the crew back on its stretchers as the bodies start the recover.

Rushing the Slide

One of the most persistent faults among crews is that of rushing the slide during the recover. The idea of rushing is about as foreign to the meaning of recover as was "grab" to "reach," some lines above. We speak of recovery of property, of recovery of health from weakness to strength, and we mean we are getting back our property, are getting back to health and strength. We have n't it back; we are getting it back, or recovering. There is an idea of gradual reacquisition. This gradual

getting back is not described, nor can be termed rushing. As convalescence looks toward health, so recovery. And the recovery in rowing, a going from the weakness of the position just after the finish of the stroke to the position of strength from which to drive the boat again, is a gradual movement in which rushing can have no part.

The slide on which the oarsman sits is a sort of movable thwart which enables him to move back and forth in a horizontal squat. It is the lack of control in bringing the slide out to the full reach that constitutes rushing the slide. The cause of rushing is mainly the fault of not getting started on the recovery soon enough, and, consequently, having to make up for lost time by hurrying the last part of the movement. More than this — more than the desire to get out to the full reach on time — is the desire to get there while the boat is on keel. It is something that suggests football to see a crew diving out for the full reach, lunging forward to tackle the water with the firm conviction that the end amply justifies the means.

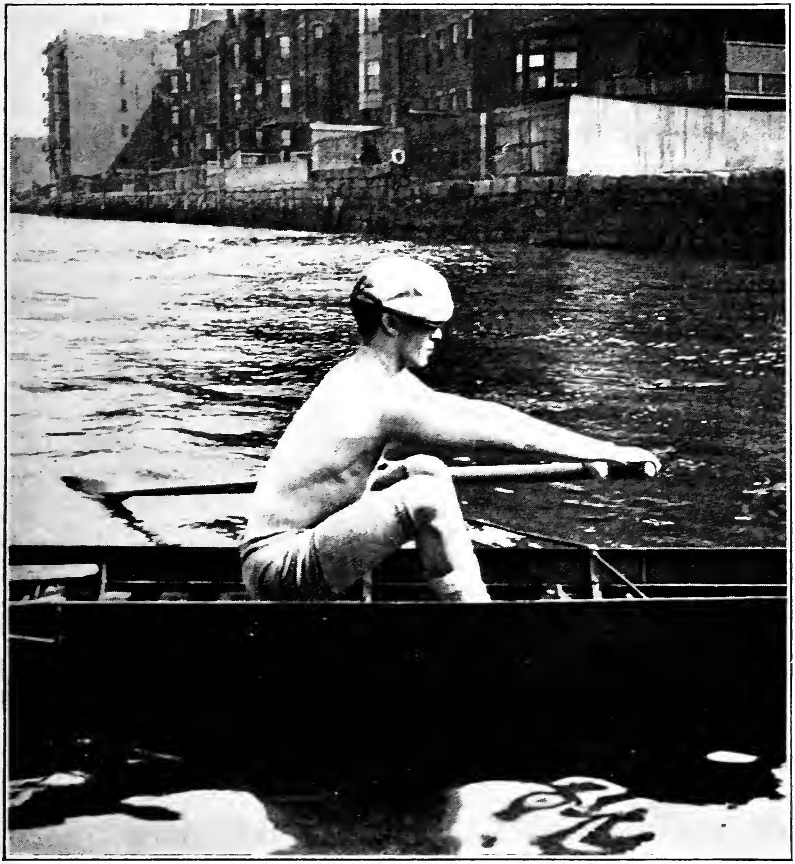
The effect of rushing the slides is to stop the headway of the boat between strokes. In rushing out on the slides, the crew acquires considerable momentum in a direction opposite to that in which the boat is travelling. To be more accurate, the crew tends to remain stationary while the boat

glides forward. So far so good. Now the crew has come to the end of its slides and is brought up on its feet all standing, and that, suddenly. Eight men have stopped themselves on their stretchers or foot braces, as if landing from a jump. These men weigh between twelve and thirteen hundred pounds, while the boat, with coxswain, weighs about four hundred pounds. Is it any wonder, then, that the boat slows down, if she does n't quite stop, when *three times her own weight pushes suddenly toward the stern* for a moment before catching hold of the water with its oars? Something must give way, and that something is the speed of the boat. The two remedies for stopping the boat between strokes are, first and obviously, slowing the slides; and, second, a quicker catch. With a slowed slide the stop is less jerky, and tends less to push the boat astern. A man may be able to crawl on all fours over ice which is so thin that, should he stand up, he must inevitably break through. So a crew, by distributing the weight that must be stopped through the recovery, instead of having the weight come to a stop all at once, — in other words, by letting itself down easily on its foot braces, — will not check the speed of the boat, and will be in a stronger position for the catch.

The other method for curing the hitching or stopping of the boat between strokes, while not altogether to be recommended, is possible to good

watermen. It consists in catching the water quicker, and before the boat can lose way. This style of stroke is more on the wound-up order, and reduces the body work forward and back to a minimum, and leaves the stroke to be rowed with legs and arms. The reason for reduced body work may be found in the speed or rapidity of the motions. It would be quite impossible for the body to keep up with the wound-up stroke without an effort which would wear out the crew. As it is, the crew rushes forward to the full reach with bodies but slightly inclined. The tendency to overreach, or to fall over on the full reach, is minimized by having this part of the movement reduced to a slide reach. The fairly erect body in its natural position permits of getting the oars in as soon as the slide end is reached, and more quickly than when, with body inclined beyond the perpendicular, the angle between body and arms is greater and the position a more strained and unnatural one.

So, then, the wound-up stroke has an element of naturalness and simplicity to commend it. The work is done by the working members—the legs and arms. It is a stroke, however, of quantity rather than one of quality. The object is how many, rather than how well. As a remedy for stopping the boat it is a superficial one, and does not correct, but rather counteracts, if possible.



THE FULL REACH IS IN THE WATER. *Page* 19.

(*Compare plate facing page* 52.)

Reach

So closely allied to the catch of the water is the reach, or full reach, that it is worth while taking it up in immediate connection with the catch. I shall consider the full reach as being more exactly identified with the catch.

The position at the full reach, or full forward, is at the logical limit of the reach proper, or at the end of the recover, so called. It is evident that the full reach is a definite though not necessarily fixed point. It remains to determine where this point is with reference to the oar blade and the water. The end of the reach, or full reach, is the end of an effort to reach something, and that something is the water. The mere arrival at the end of the body and slide reach in-board is not, of necessity, the full reach, as many seem to think. Rowing comes under the head of aquatic sports, and is not a simple gymnastic horizontal squat. The arms are the most important features in the full reach. It is they, and the control over the oar which they exercise, that let the body and legs get at the water. It is of primary importance, then, that while acting in sympathy with the legs and back, the arms still and always follow the water. And by this is meant that the adjustment of the arms for one full reach may not do for the next stroke nor

the second. The exact place where the water may be found at the full reach, the exact angle between the arms and the body, is variable as balance varies, as conditions of the water vary from stroke to stroke and from day to day.

The dictionary meaning of the word "reach" may not be entirely without a helpful suggestion. To reach for, to seek to attain, implies a gradual, prolonged effort, which is in marked contrast to the meaning of to grab after, or to snatch. In the case of reach, the idea of balance, deliberation, calculation, and judgment exists to a greater or less extent. In the case of to grab, the idea of acquisition is foremost, and the means to this end are of little moment. The same word is used, and the same general idea conveyed, when speaking of reaching for a fragile vase on a shelf as when speaking of reaching for the water in rowing. The only difference is that in one case what we reach for is fragile; in the other, that from which we reach must be carefully treated — the balance of the boat must not be destroyed by a lunging, helter-skelter grab for the water following a hurried or rushed recover.

Hanging

In connection with rushing, and as an outcome of it, we may consider what is termed "hanging,"

or "hanging at the full reach," and also "falling over." An individual may hang at the full reach, or a whole crew may be guilty of "hanging." They come to the full reach supremely unconscious of where they are for the moment. The body is as far forward as it is going, the oar blade has gone as far toward the bow of the boat as it can, and yet it has not reached anything. It has not reached the water, but hovers over it. Can a crew imagine that the boat is still to keep on travelling ahead while they hang on the full reach? It would hardly be fair to impute such ideas to any crew. What the trouble is, and why an individual or a crew hangs at the full reach, may be ascribed to two causes, the first and principal being the rushing of the slide. In the case of the individual who rushes his slide, his rushing gets him out to the full reach before he or the rest of the crew is ready to catch. To be sure, his slide has a perfectly definite line of action; not so his body. If he has stopped or come to the end of his slide very suddenly, his body will be less sudden in its halting if, in fact, the body has not been toppled over by the sudden stop. Suppose, however, that the body has stopped, as it were, close on the heels of the slide; considerable effort is required merely to halt the body, and unconsciously, perhaps, attention has to be given to the detail of this manœuvre, and the

main point has been forgotten, namely, that when the body ceases to move forward it should instantly start in the opposite direction with no pause to break the cycle or continuity of the stroke. The same reason that prompts us to slow down for a very sharp turn, as, for instance, a street corner, should dictate a similar course as the one to pursue in coming to that change of direction at the full reach. Hanging at the full reach might be described, reverting once more to the turning the corner, as coming to the turning point, stopping, facing about, and then proceeding off in the new direction. There is enough of military precision in rowing without introducing halts or conceiving of the broken continuity of a cycle.

The other reason for hanging at the full reach is that an individual who tends to rush his slide will find himself at the full reach before the rest of the crew and, rather than catch ahead, he will wait, or hang, until the rest of the crew are way forward. The remedy is the same: slow the slide and row the stroke through longer.

Falling Over

Falling over on the full reach is but an aggravated hang, or a delayed body reach. That is, as remarked some lines above, it is found impossible to stop the body at the same time as the slide;

FALLING OVER ON THE FULL REACH. *Page 23.*

(*Knees too far apart.*)

the body tumbles down into the boat and the oar blade goes skyward. The result is that before the next stroke can be rowed, the body must be lifted up out of the boat perpendicularly until it is in a position to act in a horizontal direction. The delayed body reach is hardly more than another description of rushing the slide. In this case we consider that the slide has been rushed out leaving the body behind. If the body were to stop under these circumstances at the same time as the slide, it would have acquired no reach at all and would be bolt upright or even inclined backward. It would then remain for the body to get its reach after the slide had stopped, and as quickly as possible. Getting a reach under these conditions could be little else than a lunge forward and an inevitable fall over on the full reach.

Shoot

As a remedy for this tendency to fall over we may consider the "shoot," or shooting away the hands, and the follow, or blending in of the body, with the motion of the hands.

We consider that the stroke, as far as it has been in the water, has been rowed through; the boat is moving ahead at its best speed and the oars have been lifted out of the water by dropping the hands after they have touched the body. Combined with

this dropping of the hands is the "shoot" referred to above. It is natural enough to associate a gun with the idea of shooting. The actual shooting of a gun is not a gradual act, it is sudden, instantaneous, and sharply defined by the explosion, and is consequent upon pulling the trigger. Furthermore, we speak of muzzle velocity as being the greatest which the projectile has in its flight, that is, the start is the quickest part of the flight of the shot. After this, the shot moves slower and slower till it is "spent." The requirements for the shoot in rowing are similar to those which have been noted as incident to a gun shot. The first requirement is initial velocity—getting the hands away from the body instantly, their motion being quickest at the beginning as in the case of the shot. The use of the word "toss" for "shoot" can be justified if we are willing to substitute "gather" for "catch" in rowing. It's too leisurely a term. If we are to get the oar out of the water and away cleanly, it must be done quickly with a "drop shoot."

Following

Initial velocity exists, as the words suggest, only at the beginning; and this is the part of the shoot and the only part that we need to consider, for the reason that the recover is a controlled

and comparatively gradual movement. The shoot must therefore be brought immediately under control before the arms have become straight, else there will be a hitch or break in the rhythm between the time when the arms have moved as far as they can go and the time when the heavier body can be started out after them. The blending of the movement of the body in the recovery with that of the hands and arms is accomplished by following. Having cleared the water with the oar blade, and shot the hands away, we must get after the hands with the body, or we must shoot the hands away to arms' length no faster than it is possible to follow them up with the body. And, that there may not be too much slowing down thus early in the recover, the body should be started almost at the same instant as the hands. In this way the blend between body and arms is made more gradual, and the quickness in the early part of the recover allows a perceptible slowing down for the true reach. It must be borne in mind that it is easier to differentiate between fast and slow than it is to go from a slowly started recover to a still slower full reach; for if the start of the recover be slow, the only change to be made will be to go faster, and instead of steadying down for the full reach we shall come tumbling forward, any way to get there, and "hanging" or "falling over"

will follow as a natural sequence. Following is not accomplished jerkily nor by allowing the body to stay back until the arms are straight. The recover is not jerky and is not to be done by fits and starts. To blend arms with body and body with slide, it must be the endeavor of the oarsman to make the straightening of the arms carry the body with it. He must see that the whole forward movement is smoothly continuous, and that when the arms have about finished moving at the elbow the body shall take up the motion, and when the arms and the body have moved sufficiently to uncover the knees, the slide should follow along. The greater the skill, the closer will be this following, until it will almost seem as if all started at the same moment.

Slumping

When the stroke has been rowed through and the oar is being drawn in to the body by the arms for the finish, care must be taken that the pivot shall be always at the slide, and that the body shall remain straight throughout its length. It is at this point that the back displays a tendency to round out, bending from a hinge about half way up. There are several results arising from this slump at the finish, the most evident being that if the body is not kept up at the finish, either the

finish will be neglected or it will necessitate drawing the hands in at an unnatural level, thus impairing the value of the latter part of the stroke. Another thing about slumping is that it is a perpendicular drop into the boat or a settling, and as such tends to sink the boat deeper. Following the slump there must be a recover, and this means lifting in the boat to get back into position for the next stroke.

Meeting the Oar

Closely allied to slumping is meeting the oar. Instead of holding the body back firm and rowing the oar in to it, the body is pulled up to meet the oar after the legs are down. In this way the stroke is shortened by the length of the body swing backwards beyond the perpendicular; for, if the body goes to meet the oar, we must infer that the boat is stronger than the rower, and that as he could not pull the oar and the boat through to himself, he pulled himself up to meet the oar. Slumping, then, may be called a weakening of the finish, and meeting may be termed a shortening of it. The cure for both is to stand well on the feet, and to swing straight back beyond the perpendicular, pivoting only at the hips, and holding the body firm anchored until the hands have been drawn in to it and started away again.

While the matter of meeting is up it may be well to mention the difference that there is in this one respect between scull rowing and sweep rowing. The oar handle in a sweep goes across the body and is only pulled in to it, consequently the body must swing well back in order to give length to the stroke, — particularly in a slow stroke. In the case of the sculling boat, the sculls are finished outside and past the body at the end of the stroke. This makes a shorter body swing back possible, and even allows the sculler to do what in the sweep oar would be called meeting. Only here it is not meeting for the reason mentioned above; namely, that the sculls do not have to stop at the body, but can be pulled well by it on either side, and the length of the stroke thus maintained.

II. OARS AND A BOAT

It is time to get into the boat and try some of the movements just described. An eight-oared boat is a delicate piece of mechanism, and should be handled with precision and unity of movement. First of all the oars must be brought out on the float, four starboard or right hand oars, and four port oars to be used on the left hand side of the boat. In an ordinary row boat there is no left or right to be looked out for in the matter of oars, but with the spoon oars the case is different. Each oar is "buttoned" at about three feet and one-half from the handle end. The button on the oar is a metal or leather collar around the oar to prevent its slipping out through the rowlock. The leather, which is a sort of cuff surrounding the oar and extending from the button three or four inches toward the blade, is fastened to the oar by a row of tacks in each of the edges that meet around the oar. This fastening is in the plane of the oar blade, that is, if the blade of the oar is perpendicular, as in rowing, the fastening should be uppermost in the rowlock, leaving the part of the leather which rests against the lock smooth and without joints. I have said

should be rather than *is* uppermost, because an oar may be put in a lock on either side of the boat. The oar, however, is further adjusted so that when it is resting flat on the water the blade is not perfectly level, but has its forward edge slightly tilted up to prevent its catching and carrying under when it strikes a wave. On the up-tilted side of the oar then, and when the oar blade is flat on the water, on the side nearest the bow of the boat should be the fastening of the leather. This must be carefully observed in placing the oars in their oarlocks or it will be a source of trouble if not disaster before the crew has taken many strokes.

The oars having now been picked out, are carried down and placed with blades extending over the inside edge of the float so that the blades shall not be in danger of being stepped on when the boat is brought down. If the leathers are new and dry, a little grease should be rubbed on to insure their turning easily in the locks. The eight oarsmen then take their places to lift their boat from the racks at the command of one of their number, or whoever is in charge. With four on a side the ship is carried out to the float, care being taken to keep her always "on keel" whether upside down or as she is to float. The eight men should be in step and should remember that from the instant they touch the boat and all the time that they are rowing or

handling their craft, they should act in unison and under the orders of the captain or steersman. Each man should feel the edge of the float with one foot as the boat is being put into the water and the boat should be lowered into it so that she shall not scrape or touch anything which will in anyway injure her. Further, she must go in "all at once," that is, both ends should be on a level and should touch the water at the same time to avoid straining. The men at the bow and stern of the boat hold her off the float, the coxswain adjusts the rudder, and the others get their own oars and those of the men holding the boat.

If the crew is not manning its boat directly, the outside oars should not be allowed to float with blades in the water as a breeze or current will swing the oar round so that it cannot be reached when it comes time to get into the boat. The oars should, in this case, be slipped into the locks and allowed to rest across the boat on the gunwales. The inside oars, of course, should be shipped, pushed out to the button, and the pins locked, or the oarlock closed, by whatever device happens to be in use.

Where, as in America, most crews are rigged over the keel, the men take the places assigned to them at the order, "In Starboard" (and, or) "In Port," or some like command, the side not

embarking holding the boat away from the float so that she may not rest on her outriggers.

A good many men in bringing down a boat and manning her for the first time seem to forget that they really did carry with comparative ease a craft between fifty and sixty feet long. That she was light enough to be carried must testify to a lightness of construction, as well as to the brawn of the carriers. This lightness of construction must be borne in mind when getting into the boat and the strictest circumspection exercised. Let us suppose that the order has come "In Port." We will further suppose that the port or left hand side of the boat is away from the float. The oars being in position, resting on the gunwale, the port men stand opposite their outriggers on the float facing the stern of their boat. First the port men seize the handle of their oar at the very end with the right hand, push the oar out to the button and with the right foot step on the framework, which supports the track for the sliding seat and between it at the end nearest the foot braces. Still facing the stern and still holding the oar in the right hand the weight of the body is thrown on the right leg, and squatting slowly on this leg, the left foot is placed in the foot braces, the left hand helping to support the weight of the body by holding on the gunwale till the rower is seated on the sliding seat.

The right foot is then placed alongside the left in the foot braces or stretcher. This rule, for it may be called a rule, is almost inflexible, and in the case cited above the starboard men get in in the same way. Facing the stern, the right foot is placed between the tracks on which the slide moves and on the framework, never on the bottom of the boat, and the body lowered into the seat steadied by the disengaged hand.

No rowing boat with outriggers, that depends on the oars to keep it balanced in the water, should be entered until those who are to man it have in their control that on which the balance depends.

Having taken their places in the boat the members of the crew must remember their numbers. Bow is number One, and so down to Stroke, who is number Eight. The bow or starboard side has the odd numbers, while the stroke or port side has the even numbers.

Rowing in Fours

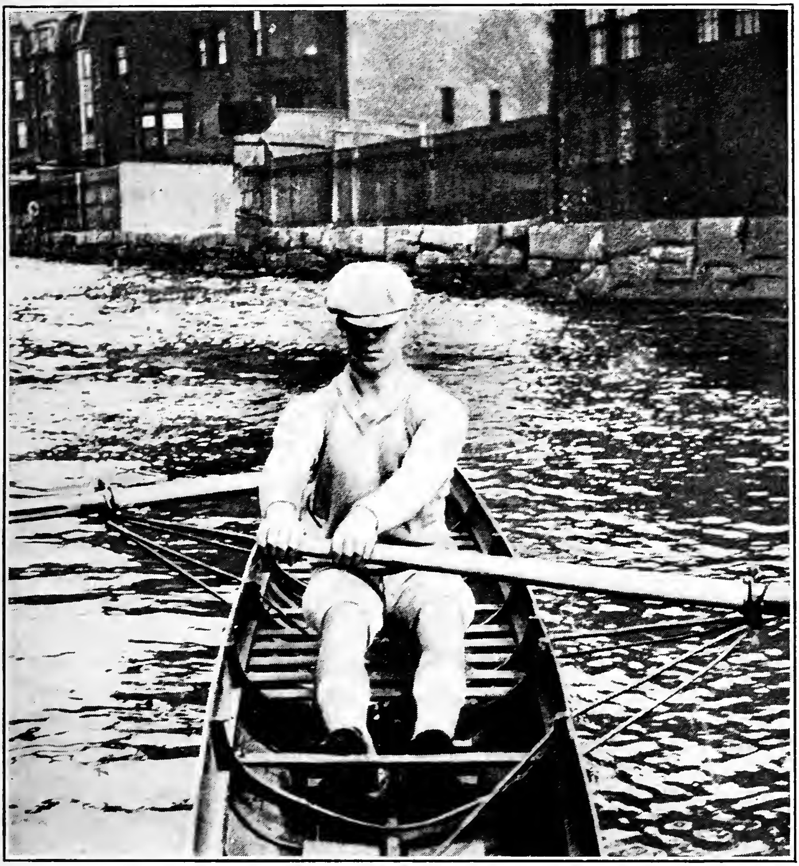
In the early stages it will be advisable to row in fours. The Bow Four, comprising bow, two, three, and four, may row for a time, while the remainder, or Stern Four, keep the boat steady. Number Five will have to give Four a little more room for his forward swing, and do this without getting his oar where it will interfere with Four's

finish. Number Five should slide up and hold his oar between his knees and his body. A similar economy of space should be practised when one side of the boat only is rowing, as in turning around. In this way, those who are not rowing keep out of the way of those who are, and at the same time they can keep the boat on keel by holding the oar handles well up and maintaining a steady pressure with the oar blades on the surface of the water.

"Waist-four"

In order to give the whole crew practice and also to link the Bow and Stern Four together without rowing the whole eight, what is called the "Waist-four," comprising numbers Three, Four, Five, and Six, may alternate with the Bow and Stern Fours, and as the crew gets to handling itself better the two men at the bow or at the stern may join with the Waist-four, while the remaining two steady the boat.

In the early stages of rowing there is enough to think of without the added effort of trying to row with the boat first with one set of outriggers in the water and then the other. It is for this reason that practice in the tank or on the machines, or else in a broad, steady boat, or a narrow, steadied boat, is quite necessary until skill and confidence are



THE POSITION OF ATTENTION. *Page* 35.

acquired. As soon as confidence and skill permit, the whole crew should row together, else with too much work in fours, the men will find that with all eight rowing, the boat will run away from them at the beginning of the stroke and they will be slow in catching up, or will fail really to drive the boat until the stroke is half over. A half stroke may be better than no rowing, if one is willing to do things by halves, but it is at best a lazy way of getting a boat along.

Each man in the boat should be sure, since his oar is in an oarlock, that he has fastened the lock. The oarlock, if left open, is liable to spread, and let the oar slip out at an awkward moment when the crew is backing or holding, or when the water is rough and the oar strikes a wave during the recover.

The Stroke Unit

Having pushed off from the float let us suppose that the coxswain gives the order "Attention, Stern Four." Five, Six, Seven, and Stroke sit erect with legs down and thighs horizontal, hands grasping the handle of the oar and far enough apart to give room for the body between them, at the finish of the stroke, without having to pull either hand across the body. The arms should be straight, the oar blade flat on the water, and the

stern four prepared for the next order "Ready." At this, they reach forward, and because they have a slide they reach with it as well as with the shoulders. That is, the same word that naturally governs the forward motion of the shoulders should also govern the movement of the slide. If this is observed, there will be *slide reach* instead of slide rush out to the full reach. Then comes the order "Row" or "Paddle." The oars are turned so that the blades are perpendicular and covered in the water, the back and legs are started, the arms remaining straight until the legs are nearly down and the back past the perpendicular. Legs and back having done their part of the work there still remains the draw-in with the arms to finish the stroke. This should be done steadily and smoothly and not with a jerk, pulling the body up. The boat is now in motion, and in order that the oars shall not drag or stop her, the blades must be lifted out sharply and the body brought back to attention. To do this requires that the hands get away from the body, where they have just finished the stroke, sharply, with a "drop shoot." Instead of waiting at the attention, however, the recover is carried out to the full reach and the stroke pulled through again. The start was made at the order "Attention," and the stroke beginning there is not complete until the body and oars are once more

in the position of "Attention." The boat could not move ahead if the oars were to stop at the finish because as we have seen the finish is part of the stroke and is in the water. If the boat is moving and we call the finish the end of the stroke, or the end of the cycle of the stroke, we shall only move the boat the length of that back swing. The oar blade must be lifted out and away ready for the next stroke. If the order be to "Let her run" (stop rowing), we must be prepared to "Hold" or "Back," as may be necessary. The position of attention is the best starting point for another stroke or for a change such as is involved in backing or holding, for it permits the boat to run along, oars flat on the water and offering the least resistance to it. On the other hand, if it is necessary to stop the progress of the boat through the water, the position of attention, with body erect and arms straight, gives the body, already in a strong position, more time to adjust itself to this requirement than if the oar were in close to the body, as at the finish.

But to return to our Stern Four. They are rowing each man for himself. Later we may be able to say the Stern Four *is* rowing, but at present they *are* rowing, and we may look at them and see what the most obvious faults are. For the time they have not to concern themselves with keeping

the boat on keel, the Bow Four are looking after that.

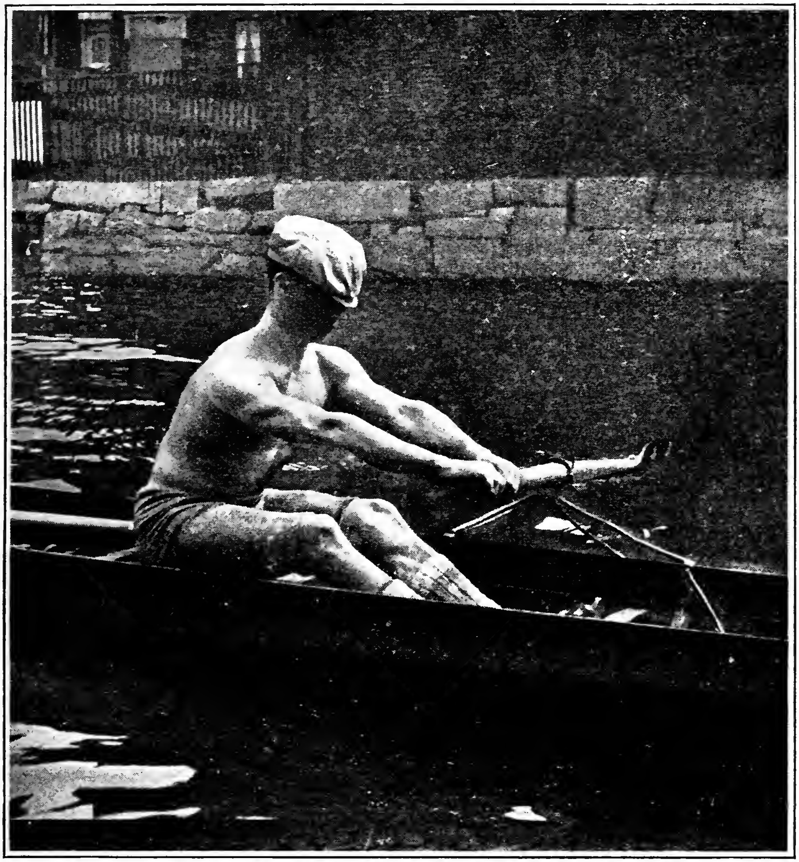
Stroke, or number Eight, has evidently rowed before, as his ability to put his oar in and take it out of the water clearly shows, but his inboard work needs brushing up. He gets forward well, but at the catch it is plain that the work is done not from the stretcher but from the seat. In other words, he catches by lifting with the shoulders and body, and lastly the legs are straightened out, apparently more with the idea of getting the knees out of the way of the oar handle than for any other reason. Stroke has a very good reason, no doubt, for his style of rowing, and he would justify it (if he were in a position to do so) somewhat as follows: He would start with the idea of first making sure, and then going ahead. That is, first get hold of the water and then go ahead with the rest of the stroke. Or to express it differently, he wants to be sure that his oar is buried and holding, or even starting the boat before he uses his legs. He knows that if he starts to use his legs by pushing against the foot braces or stretcher before he has caught the water, he will stop the boat, because he and the crew behind him in all probability outweigh the boat they row in, and should they start to drive the legs down before the oars were anchored in the water, the boat

would be pushed astern, or at least perceptibly stopped. The idea of first making sure, — of not rowing a stroke until he has made sure of catching or getting hold of the water with the oar, — could n't be improved upon. It is in the working out of that idea that our number Eight missed the point. Looking again we see that he is, as it were, putting his oar in the water with the movement of his body and shoulders, instead of reaching for the water with his blade as he comes forward. Stroke needs to limber up in the shoulder joints; he must *increase the angle between the arms and the body as he comes forward to the full reach.* He must exert less downward pressure on the handle of the oar in coming out on the forward swing, and when he has reached the end of that swing, he must remove all downward pressure on the oar handle and let the blade drop in of its own weight. Then he will have made sure of having hold of the water, and the sooner he follows up this getting hold with a long pull, a strong pull and, best of all, a pull all together, that is, legs and back together, the more effective will his rowing be and the less of jerkiness and forgotten leg drive will there be. There will be less of sore knees and more of honest leg-tired feeling, too, if he will take the initiative and drive the legs down before they get in the way of the oar handle. His catch will be quicker,

because where he formerly depended on the snapping up of the back from a motionless slide he will now, in catching from his foot braces, add to the speed of the back, the speed of the slide, and incidentally add to the speed of the boat.

"Don't try to row the whole boat yourself, number Seven." As a matter of fact, we might say this to the whole Stern Four. They are all pulling hard, as if their lives depended on it, or as if they wanted to get it over with.

Number Seven is a long-bodied man with rather short legs, and, as is quite usual in such cases, he has been economical with his development, devoting his training to the shorter half, with the result that his thighs and legs are very powerful, while the trunk and arms have only a moderate development. There is no trouble here about the legs getting down out of the way as in number Eight's case. Seven is slamming his legs down hard at every stroke, but he has set too fast a pace for his body to follow. He is using a comparatively short slide. This is natural enough because his legs are short. To make up for the shortness of slide he is swinging a little further forward and back. And it is in the swing that the body gets behind. At the catch, could we see but the legs, we should say that Seven was a remarkable man, but we notice that the body is unable to hold what the legs



KICKING OUT THE SLIDE. *Page* 41.

(*Legs almost down; shoulders not started. A common fault.*)

undertake to drive. The body and shoulders are left behind at the catch and don't begin to hold or pull back till the legs are almost down. The slide moves faster than the shoulders on the catch. Seven is "kicking out his slide." He is "biting off more than he can chew." But he is not disheartened yet and, if we may continue the simile, we see him toward the end of the stroke give a convulsive movement, which may be likened to swallowing, and with a jerking in of his arms he finishes with his oar in the pit of his stomach, his body curled over it. It was bad enough to attempt too much, but the summary disposition of the overload, with the body alone, is even worse, however good the intention. Seven has heard Stroke asked to use his legs and he takes the hint to himself, and with what result? Not only is his oar anchored out at the full reach, but his shoulders and the upper part of his trunk also stay there, and as the slide drives back and the body sinks lower in the boat, he is in a weak position, when at last the body is able to rise, after the legs have been driven down. I speak of the body's rising in the boat after being pulled down by the oar and may add here, that, as it is the object in rowing to get ahead in a horizontal plane, every up and down motion of the body is a waste of energy and a hindrance to the boat. For when Seven lifts his

body as he must do before he carries it back to the finish, he makes himself just so much heavier during the time of the lift; he makes the boat just so much heavier or deeper in the water. He makes the boat displace more water — have more wetted surface and consequently increases the friction and retards the progress. And now before we leave Seven we must reiterate what we first said to him about not trying to row the whole boat. We may very properly caution him about jerking with legs at the full reach and with arms at the finish. He must remember that a chain is no stronger than its weakest link. If the legs are stronger than the back, the legs must give way a little and on its part the back must work a little harder, so that it may not be all concession but rather a leading up to a full application of power on the part of both body and legs. The one in leading must not be hopelessly far ahead and the one following must not hang back or try some other way separate and distinct from that which the leader is pursuing. Sympathy there must be. Sympathy to anticipate or to assist, to unite or to strengthen the various efforts made, and to make intimate and ally the parts of the human mechanism, eliminating any complexity or difference, the loopholes through which faults creep in. Take it a bit easier, Seven, carry through from full reach to finish a handful

of oar all the way, a handful, not a handful at the catch, two fingers' worth in the middle, and a wish that you had three hands at the finish. Get the shoulders on and don't lie down at the finish; and we turn to number Six.

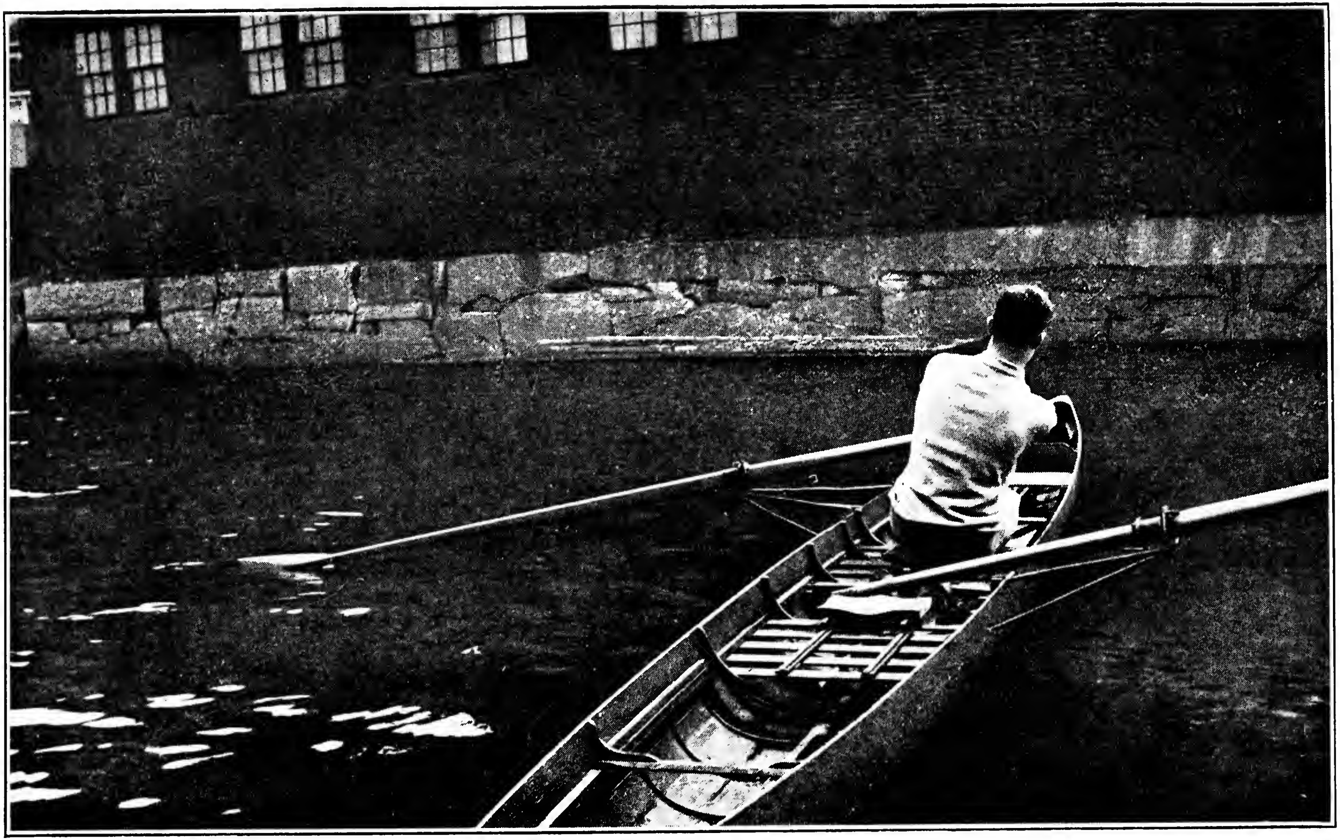
Before watching number Six, however, we may have noticed an inclination on the part of some of the men in the bow to take off their sweaters; whether in anticipation of being called upon to row or to display physique, we cannot stop to analyze. Suffice it to say, that there is no camera about, nor can the coach stop to feast his eyes on a fairly well-built number Two or a muscular prodigy at four. The writer remembers that the most perfectly built man of his acquaintance was asked to try for a crew; and this Herculean Adonis was quite hopeless and slow and altogether unfit for the quick changes of direction that are demanded of the oarsman. None of the Bow Four may come under this category, but in order to avoid getting chilled it is of importance that those who are not actively rowing should keep covered, particularly during the spring or fall rowing practice.

It is better to be too warm than too cold. A chill caught on the river will work much more detriment to the candidate for a crew than will the exhibition of his physique benefit or increase his

chances of making the eight. And if by reason of being caught with his sweater on he has to row a fairly long stretch and loses, say a pound or two, he will make up that loss in a meal and be as well or better for it. On the other hand, if he catches cold he lays the foundation for many other troubles, which impair not only his value in the crew but his general health.

Number Six, don't swing round your oar, keep your body opposite the stretcher, and let the hands and arms connect you up with the handle of the oar, whether the handle is over the keel or over the side of the boat. This brings up at once the question of whether the best pull is not at right angles with the oar. The oar being pivoted swings in the arc of a circle. Should not the body follow the example and swing in a similar circle to enable the pull to be always at right angles? And right here we must choose between following the oar and what may be called following the stretcher.

That which is of prime importance is power, other things being equal. To maintain power a strong position is necessary. The strongest position is that in which the body remains in a perpendicular plane, passing between the heels and extending parallel with the keel; that is, the body with the shoulders and legs should be made to keep opposite the stretcher in order that the maxi-



Swinging Around the Oar. *Page* 44.

mum of power may be had from them. If we are to maintain this maximum of power, the arms must do the adjusting. In this way the power itself is left unimpaired by any leaning from side to side. The human engine will work better, longer, and more satisfactorily the simpler its mechanism and movements are. If the position at the full reach, where it is manifestly impossible to pull at right angles with the oar, is not ideal, then the body and legs must be kept in an ideal position to make up in quantity or power what they lack in quality or in the directness of application of that power. The arms, from the catch to the time when the legs are almost down, are little more than straps, — straps rather than connecting rods, because they must have more than the freedom of movement allowed by a pivot. There is the perpendicular movement of the catch, and then the horizontal descending movement while the legs and back are moving.

Some explanation of a horizontal descending movement may be necessary just here. The best idea may be gained if we stand erect, with both arms extended to the front and raised so that the angle at the armpits is the same as the angle at the full reach in rowing. Now, instead of moving the body as in rowing, move the arms, the hands being on a level and four inches apart, until the angle at the armpits is the same as in rowing just

before the arms break for the finish of the stroke. This movement in relation to the body will be a perpendicular one; but there is another, a horizontal move to the left, demanded of the arms, and the one that we have just been commending to number Six's attention. He has failed to get the horizontal arm movement and has in consequence been swinging round his oar, or, as we said before, keeping his body opposite the handle of his oar instead of opposite his foot braces. His arms have had the stiffness of connecting rods with but one joint, rather than the suppleness of straps with a sort of universal joint. If Six were to go through the movement outlined above, his body would move horizontally to the right or left according as he had a port or starboard oar.

The principal thing to be noticed is, that in the rowing, care must be taken to have the shoulder muscles loose and the joints there able to take care of the horizontal descending motion, which, in the boat with the oar, is a horizontal arc. It is not as if one had to begin or finish the stroke with the hands off keel. At the full reach the hands are directly in front of the shoulders, and at the finish the same is true. With two ends to tie to and the keel for a guide, when, in the middle of the stroke the tendency to lean is uppermost, number Six should find no difficulty in keeping upright and

steady in his swing. In acquiring this over-the-keel habit it will come much easier if the stroke is rowed with but little power for the time being. When the feeling and assurance of having acquired this knack comes, then the power may be gradually increased until the full power stroke is rowed.

Five, steady down on your slide. You are rushing out to the full reach too fast. In fact, if Five were not one of the strongest men in the boat he would be in a fair way to have many other faults, resulting from lack of control of his slide in recovering.

Some people hurry because they are late, others because they fear being late. Five, we will say, is afraid of being late, so, directly he gets his oar out after the finish of one stroke, he thinks only of being ready for the next stroke, and out he comes on his slide like a young avalanche. He has the goal in view, and the means of getting there on the slide are so obvious that he does not realize what effect his quick rush forward and sudden arrival at the end has on the boat. His quick stop is a push toward the stern and opposite to the direction in which he is trying to propel the boat.

There are three parts to the recover. The nearer we get to the stretcher or the boat itself the more care has to be exercised. Arms and body start the recover, but have little or no effect on decreas-

ing the speed of the boat, and may even help the speed, if started sharply enough. It is not until the slide begins to move forward, not until we get right down to the stretcher, that the ways and means of stopping have to be considered. As soon as the slide starts, however, we must think of stopping, must feel for what is going to stop us, must feel the stretcher with the feet more and more as we slide out toward it. To use a different expression, we must "let ourselves down easy" as we come forward towards the full reach. The weight of the body as it comes more and more on the stretcher must be distributed throughout the recovery. The sooner the distributing process begins the less will be the kick astern as the body arrives at the full reach.

Time

Stern Four, let her run; get your sweaters on. Take her up, Bow Four, is now ordered. Mind your time, Bow and Two. Number One and Two are rowing by themselves, as if there were no one else in the boat.

Faults in time are always to be corrected as soon as noticed, and here is where the coxswain should keep a careful lookout, for he can see the oars at all times, though he may fail to see errors in the inboard work of his crew.

Number Four, let your elbows come in close to your body, not out at right angles. Number Four has never tried pulling himself up to his chin on a horizontal bar, or, if he has, he forgets how he did it, or how his arms adjusted themselves for that effort,—how the forearm was always perpendicular to the rod or bar on which he was chinning himself. This is almost exactly what he is doing in the boat, only here he lets his elbows swing out until the forearms are almost in line with, or parallel to, the oar. While Four is working this out for himself and practising in the boat, let us see just where the mistake of this arm movement comes in.

First of all, rowing is pulling an oar, not pushing it. That is, the oarsman is working behind his oar, and he gains nothing by getting round in front of it with his outside hand, just before the finish, and pushing the oar in to his body the last three or four inches by a contraction of the biceps muscle alone. As to the other arm, its inability to get in front of the oar dooms it to a pull along the shaft in the direction of the oarlock. But we have seen, or if we have not seen we can discover by experiment, that when we have a heavy lift, as in pulling ourselves up to a rod, or to a ring, or in lifting a heavy object from the floor, we lift with the forearm in line with the direction of the lift; that is, the forearm will be perpendicular for an up and

down lift. In rowing, the lift, so called, is tipped over on its side and becomes a horizontal lift or a pull, and the same holds true as regards application of power. The forearm is a strap with a hook on it from the time the oar is covered until the oar handle comes in to the body. To make the outside hand climb round the end of the oar and push the finish of the stroke in to the body while the inside hand presses the oar against the button is to lose much in effectiveness of the finish.

Without entering into a detailed consideration of the muscles used in the latter part of the stroke, we may say that the most important are the biceps, which flex the arm, the trapezii, which draw the shoulder-blades back toward the spine, and the latissimus dorsi, which draws the arms inward and backward. Our number Four is using his deltoids overmuch on the finish, and in so doing has lifted his arms out from behind the oar, complicated muscular action, and has detracted from form as well as substance at the finish of the stroke.

Furthermore, the shifting of the hold on the oar at the finish throws more work on the inside hand when it comes time to lift the blade out of the water. In fact, if we watch number Four closely, we shall see that his outside hand loses hold of the oar entirely, just after the finish of the stroke. The whole

STRONG POSITION ON FULL REACH. *Page* 51.

(*Knees in line with shoulders and feet.*)

matter of lifting the blade clear of the water and carrying it forward in the "shoot" is thus thrown upon the inside hand with its decreased leverage and consequently diminished control.

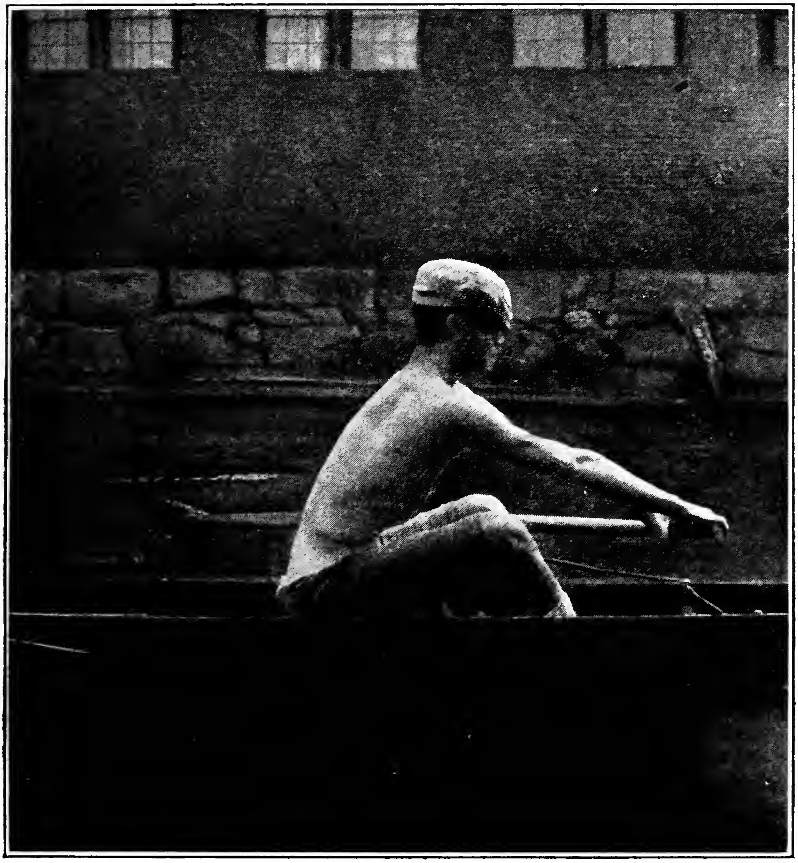
In the days when the tholepin was in use it was customary to caution the oarsman to keep an outward pressure with the hand nearest the pin in order to keep the button on the oar close against it. This practically resolved itself into an injunction to row with the outside hand and recover with the inside hand. And while this idea still underlies stroke and recovery with the modern rowlock, the inside hand should act as pilot and adjuster of feather and bevel in conjunction with the outside hand and not alone.

Number Three, keep your knees close together on the full reach. The knees should never be further apart than the width of the shoulders. Their being nearer together than this depends somewhat on the build of the oarsman. If he be stocky he will probably be more comfortable at the full reach with his knees apart than he would with his thighs pressing against his stomach and interfering with his breathing. Number Three will not go far wrong if he opens his knees so that they will be in a plane, which shall pass through the length of the foot and the shoulder-blade or armpit. This position is the one naturally taken by

most people when they squat down, and it has the further advantage of preventing the body from falling too far forward on the full reach. At the same time it allows the lower part of the body a comfortable space for its reach.

It must be remembered that the whole body is to reach not merely the shoulders. It is important for the breathing that *the stomach should not be drawn in to interfere with the downward expansion of the lungs.* A man who allows his knees to fall apart so that they rest almost on the gunwale of the boat at the full reach has, in nine cases out of ten, first to clap his knees together before he can drive his legs down. The most evident inferences that can be drawn from number Three's position on the full reach is, that he did not use his stretcher in his recovery. If he had used it he must have kept his knees closer together to support his weight as he came out to the full reach; for we notice that before he drives down his legs, or puts weight against his stretcher, there is a preliminary gathering in, if we may so call it, of the knees, in order that he may apply his power in a straight line or in one plane.

We spoke about the thighs being more or less of a support for the body on the full reach. They define the limit of a strong full reach position beyond which the body must lose effectiveness,



REACHING WITH THE SHOULDERS. *Page* 52.

(*Stomach drawn in. Deep breathing impossible. Thoroughly bad position at the order "Ready." Slide reach neglected.*)

Bow-Legged Full Reach. *Page* 53.

(*Knees must first be brought toward each other before a strong drive is practicable.*)

because it drops down into the boat, and the little additional reach gained is more than offset by the extra effort required to lift the body up before it can swing strongly back. We may leave Three for a time, then, with the injunction not to row either knock-kneed, or, at the other extreme, bow-legged, but rather to toe out, as it were, with the knees, keeping them from six inches to a foot apart at the full reach.

Number Two, you are slumping at the finish. Hold your body firmly back and feel your stretcher at the finish, just as you do at any other part of the stroke.

Any part of the stroke or pull through is performed from the stretcher, and therefore the finish or end of the stroke must be executed from the stretcher also. The finish or end of anything is as much a part of the thing itself as the beginning or middle. At the finish of the stroke the body should stay firmly back as the hands are drawn in, so that the connection between the hands and the stretcher may not be impaired by a slump or yielding of the back. Slumping usually results from a change of pressure on the oar just before the finish, and might be called, "over-finishing." It is not unlike the slip of the driving wheel of a locomotive. The remedy is the same — "sand," and the even application of power.

Number One, or Bow, keep your hands nearer together. You want one hand on the end of your oar, and the other just far enough from it to allow room for the body between them for the finish of the stroke.

If Bow should try to pry a stone out of the ground with a crowbar, or if he should attempt to draw a nail out of a board with a hammer, he would n't have to be told to apply his power as far away from the fulcrum as possible; and yet, there he sits with one hand two or three inches from the end of the oar and the other hand halfway to the rowlock. He has a lever and a fulcrum and that which corresponds to the stone or the nail. The oar is his lever, the rowlock his fulcrum, and the water is what corresponds to the stone or the nail. The only difference is that his object in rowing is to move the fulcrum, instead of the water. In either case he needs all the leverage he can get, if he is going to do effective work. It would seem, then, that the two hands ought to be close together at the very end of the oar if his pull is to have the maximum of effectiveness.

Suppose we watch Bow with his hands close together, first on the full reach, or, if we can't see him, try it ourselves. Extend the arms straight out in front, hands closed, palms down, thumbs together, and discover that this position tends

to cramp the chest. Then try hanging by the hands from an overhead support, and observe where the hands naturally take hold, and see that they are about as wide apart as the shoulders. In these experiments we have been considering or studying our own convenience, but if we apply it to the theory of the lever, we find that having the hands wide apart is not good doctrine. But there is one more thing to figure on, and that is on the side of our convenience, and also on the side of effectiveness; namely, the necessity of having room between the hands at the finish of the stroke for the body. If this room is not left, the hand nearest the fulcrum or rowlock will have to be pulled in across the body and move in line with the oar, instead of at right angles to it.

One more reason for keeping the hands but four inches apart is that at the full reach the inboard end of the oar is the point farthest from the body, and if both arms are to be straight, while reaching to unequal distances from the body, it will be impossible to keep the shoulders squarely opposite the stretcher if the hands are wide apart. About a hand's-breadth between the hands on the full reach, a level wrist on the outside hand and a bit of arching to the inside wrist is an adjustment which leaves the shoulders almost equally forward and the body squared away for the stroke.

III. THE COXSWAIN

Up to this point we have only commented on the work of those who are rowing, but there is one of the crew who is an important factor. It is the duty of the coxswain in the stern to be eyes for his crew, and a mentor to correct not only evident errors in time outboard, but errors in feeling inboard. The most common wrong feeling that the steersman can have, resulting from something which he cannot well see from his position in the stern, is a tendency to fall towards the bow of the boat as the crew comes to the full reach. He would bump his head against stroke's oar if he should yield to the impulse which he feels at the forward reach of his crew. If our coxswain analyzes the cause of this, he will first see that he falls forward because the seat on which he sits has suddenly moved backward, or at least that the onward progress of the boat has been suddenly checked, while he tends to keep on moving to the front. The crew then has stopped the boat, as it has come to its full reach, between strokes; that is, the crew is rushing out to the full reach with but one idea,— the idea of getting there, and never

mind how. It is easier to tell the crew to slow down its slides than for the crew to do it; and in order that the coxswain may realize some of the difficulties which he will later labor with the crew to obviate, he should, at his first opportunity, get into a steady sculling boat and learn to manage the oars or sculls for himself.

More important than the rowing for a steersman is his careful study of the way a light boat is acted upon by oars. He should note that the stern of a boat is the part that moves in turning, and that the bow is the pivot. With these points to be picked up in his spare time by himself, we must counsel the man with the tiller lines to use his rudder sparingly. If he is to change the direction of his crew, so as to bring it round a curve, he should begin before he gets to the curve to swing his stern away from the projection he is to pass, and in general get his boat round into the new direction.

In applying the rudder to accomplish this, he should time his rudder strokes with the oar strokes of the crew, rather than carry his rudder on continuously; that is, he should begin to put the rudder on as the crew gets hold of the water at the catch, and leave it off as the crew finishes the stroke. In this way he imposes no handicap on the crew between strokes, and turns the boat while the eight

oars are in the water supporting it; for, if the rudder is kept on steadily until the turn is made, between as well as during the strokes, the problem of keeping the balance of the crew is decidedly complicated. The boat is now moving in a curve, but the bodies of the crew tend to keep on in the original straight line, or, speaking more technically, tend to go tangent to the curve. This tendency is met, during the stroke, by the support of the oars in the water, but when the support is withdrawn during the recover, between the strokes, the tendency of the boat to roll off keel, away from the direction in which it is being turned, results either in a very sloppy, off-keel recover on the side away from the turn, or, if the crew has tried to counteract this tangential lurch by leaning in with the bodies, the chances are that they will overdue the leaning and roll down on the side towards which they are turning. In either case the result is far from beneficial to the speed or temper of the crew, however effective it may prove in getting the boat turned in the new direction.

Turning around

There are unquestionably times when a heroic use of the rudder is necessary, where stress of circumstances demands that a sharp turn be made, either to avoid some obstruction or to get round

a sharp bend in the river, made more difficult by reason of a strong current. The latter reason for using the rudder continuously is hardly to be considered seriously, for the coxswain should know his currents before he leaves the float, or at least, if he steers a crew on tide-water he should know whether the tide is ebbing or flooding, or whether it is slack water. It requires hardly more than a glance from a bridge or from the bank of the stream to take in the conditions and direction of tidal flow. An understanding or a knowledge of such items will save a deal of steering in the course of an afternoon's row and may save running aground, or into bridge piers, or missing a landing at the float.

There is an easy and a hard way to turn an eight or a four oared boat round, where there is a strong current, or in fact where there is any current; as, for instance, in the upper tidal reaches of the Charles River above Cambridge. We will take two cases. In the first we will suppose that the crew is rowing down stream with a following current and it is desirable to turn about. The boat should be first steered into mid-stream, or into the strongest current. Then by means of the rudder and by having port row, the bow of the boat is swung in towards the bank where the current is slack, while the flow in mid-river swings the stern round down stream and helps turn the boat.

In going against the current and turning, the boat should first be steered into slack water at one side of the river, and then with rudder and oars, the head of the boat should be swung out into the current to be helped round by it. In both these manœuvres it should be remembered that it is the stern of the boat that moves most, in nearly all cases, so that when possible the stern of the boat should be in a position to benefit by any advantage in flow of the current, as in turning from going with the current. At least, the stern should have as little to work against it as possible, as in the case of turning from going against the current. These points, simple enough in themselves, if followed out, will save time and effort to the crew, and will also relieve the boat itself of no small strain and rack.

Having reminded our crew of some of the more common faults in inboard work and posted the coxswain on what is expected of him under ordinary conditions, we may turn around and head back to the boathouse. On the return we shall consider the outboard or blade work more particularly, and when possible show how faults inboard are reflected in the outboard work.

The coxswain in turning the crew round should be considerate enough to let each side do a part of the turning. If he turns to starboard, the port

oars should row the boat until it is about at right angles with the original course, and then the starboard oars should hold and check the way of the craft and back water until the boat is completely turned. *The steersman must be careful to have his rudder straight and his rudder lines drawn taut when the crew is backing*, otherwise the rudder is liable to break from its fastening. If the rudder does get away from him while the crew on either side is backing the boat, he should, provided there is room, stop the crew and have one or both sides take a stroke or two until he can get his rudder straight. It is easier to correct a fault at once than to row back without the rudder and take the risk of breaking the boat at bridges or at landing.

IV. OUTBOARD WORK

WITH the Stern Four rowing, it is noticeable, first and foremost, that the blades are not going into the water together. Number Eight's oar is coming out before anybody else's; Seven is late in catching; Six is exploring the depths and has just missed the bottom of the river with his blade; while Five has a sort of skyscraping action at the first part of his stroke and fails to get down to the water until half-way through.

Eight, you are rowing your oar into your lap. Let the hands come through at the same level all the way from the full reach, and have the finish high enough on the body to allow the hands to drop down and shoot away without touching the thighs on the recover. As it is, Eight is finishing in the air instead of holding his grip on the water cleanly through to the end of the stroke. He must remember that the finish of the stroke is just as much a part of the stroke as the middle or beginning, and as such it must be in the water. Don't work quite so hard on your finish for a while, Eight. Let the oar float in to your body and note at what height it comes. Now begin to *make it* come in at

that height easily, at first, increasing the draw with the arms as you get more into the swing of it, until you can carry a full firm pressure from beginning to end.

Seven, you are slow in getting hold of the water, and this comes partly from your tendency to kick away your slide, which we were working to correct when we started out. Get the shoulders on sharply, and turn round at the full reach with more life. Stop gathering, in that gradual fashion, and catch the water sharply and decisively. Seven puts his oar into the water as if he were reaching into a basket of eggs and did not want to break any. An eight-oar is too quick in the water to allow of the first part of the stroke being made soft or easy. The change of direction, the getting hold of the water, must be quick, and the catch must be faster than the motion of the boat. It is not right to start behind and figure on catching up with and giving a final boost to the boat at the finish. Keep ahead; pull the boat up to you; don't pull yourself up to the boat.

Six, don't chop your oar in at the full reach; drop it in. Give the oar its weight on the full reach and it will drop in quickly enough, if it has been given the proper bevel just before it is ready to go into the water. Six is rowing his oar in at the full reach as if he had to break through some

thin ice with his blade before he could get at the water. As a result of this chopping in, the oar goes down much deeper than there is any need for, and when, at the end of the stroke, he wants to get it out cleanly, the oar is so deep that it is hard to get it clear without lifting a good deal of water and pulling the boat down in consequence. *Use your spoon oar as if it were a spoon,* number Six, *and not as if it were an axe.* Scoop hold of the water out at the full reach. Get down somewhere near the water as you come out to the catch. *Do your rowing in the cream, don't get down into the skim milk.* Do as little up and down work as possible and save your energy for the horizontal effort. Make the stroke and recovery, as far as the path of the blade goes, as near parallel as possible. Remember that the boat is to be moved horizontally, and to do this power must be applied horizontally. Every up and down movement, therefore, not absolutely essential to getting in and out of the water should be avoided.

Clipping

Five, don't clip. Get your blade in where you reach. Raise the hands as you get forward and feel for the water. Don't turn round, — don't change your direction in the air. Make your full reach mean something. You only stop the boat

by missing the first part of the stroke, for on the catch or turn round you only push against the stretcher — that is, against the boat — until the oar strikes the water. This is a push in the wrong direction and stops the boat when you ought to be pulling it along. Get your oar into the water as part of the recovery, not as part of the stroke. As a matter of fact, the getting in is not only the end of the recovery, but also the beginning of the stroke. It is therefore doubly important that this point should have careful attention and be thoroughly understood. Instead of bearing down with the hands and carrying the handle of the oar toward the bottom of the boat after the oar passes over the feet, lighten the pressure of the hands. Keep level. Hands up, head up, shoulders up, everything moving out on a level, not down.

Reaching Something

As reaching carries with it the idea of reaching an object, what could be more useless than for number Five to reach forward three or four feet beyond his objective point? If he is going to clip, why reach so far? Let him decide at what point he will catch the water and only swing to that point. Here, at least, his stroke will be effective, — what there is of it. And if it does not seem as effective as it should be, he has only to decide to

have the point at which he will get his blade into the water a little nearer the bow of the boat.

The Stern Four now stops rowing or paddling, puts on sweaters, and the Bow Four "takes it up."

Four you are letting up on your finish. Keep a good handful of oar way in to the body. Keep the water piled up in front of the oar, a "heaping spoonful" and low behind, so that the blade will come out clean. Keep the elbows down, and let the pull with the arms come straight in by the body. It is the firm, hard, clean finish that sends the boat running between strokes. Don't jerk it in, *Four.* Feel at the finish that the pull in of the arms keeps the feet firmly against the stretcher until the hands shoot away on the recovery. The arms, as they bend for the draw in to the finish, must keep the feet as firmly braced as when, earlier in the stroke, they were but the straps or connecting rods which attached the oar to the body.

Three, take your oar out of the water before you feather it. You are *feathering under water* and dragging the water up with your oar. The blade should be lifted perpendicularly out of the water in the same position that it occupied when being rowed through, and, when clear of the water, feathered and carried along horizontally out for the next stroke. Feathering under water (see

THE FINISH: A STRONG POSITION. *Page* 66.

(*See also plate facing page* 54.)

plate) is probably more productive of what is called crabbing, or catching the water with the forward edge of the oar on the recovery, than any other single fault. By lifting the blade out perpendicularly at the finish before feathering it, we are simply recognizing a fact from geometry, — that a line from a point to a plane perpendicular to the plane is the shortest distance between the two, — and, conversely, in applying it to the present discussion, the shortest and quickest way to get clear of the plane of the water is to go straight up from it. The reason for taking the shortest cut to get away from the water is pretty obvious, for at the finish the boat is travelling at top speed, and one cannot be too expeditious in getting the oar blade where it will not retard the progress of the boat.

Two, you are "cutting under" with your blade. See that your oar blade is straight up and down before you begin to pull. You are leaving a little of the feather on your oar, and your oar goes in obliquely instead of perpendicularly. To get the greatest effective push out of the oar, without either lift or drag, the blade of the oar must be vertical and the push against the water horizontal. If, as in Two's case, the oar is rowed with the slant, the upper edge of the blade being nearer the bow than the lower, any application of power horizontally will cause the blade to cut down into the

water, because the balance of the blade has been destroyed. In his endeavor to prevent the oar from cutting under, he must apply his power at right angles with the blade. In other words, he must pull down on his oar, and this pulling down acts to pull the boat down, because it is a lift of the water.

Bow, clear the water on the recovery. Take your blade out clean at the finish and carry it well off the water until you are ready for another stroke. Bow has perhaps the hardest position in the boat to fill, but that does not excuse his shuffling his oar along over the water on the recover. Let him think of the oars of the boat as legs, and the blades of the oars as feet, and let the crew lift these feet and walk the boat along, taking care not to drag them between strokes or steps. We want no carpet-slipper shuffle on the recovery, — either in the water or out of it with the oars; no half-way work.

Making a Landing

Coxswain, you have a strong wind behind you and a little current under your boat. You had best run by the float, turn round, and make your landing against the wind and current rather than with it. In this way a more gradual landing can be made and the risk of running into the float at

too great a speed avoided. With a frail boat, too great care cannot be exercised in landing. A broken bow or a bent outrigger must not be chanced when a little more time and regard for conditions would have prevented the accident.

V. ALL EIGHT

After a sufficient time for practice in a steady boat, or in a light boat made steady by having only one four row at a time, the crew arrives at the stage where it must try "a stretch all eight." The time has arrived when the individuals in the crew must begin to blur, and a larger individual, the crew unit, must be evolved. For the first time we may start the crew off with the Bow Four rowing, and then have numbers Five and Six join in, and presently, when the Bow men get used to increased quickness of the boat, let Stroke and Seven fall in with the rest.

The first thing outside the unsteadiness and tendency to roll to be noticed is the quickness of the boat in response to power applied, and the failure of the crew to apply its power quickly enough at the beginning. That is, the boat must be caught quickly and dropped quickly at full reach and finish respectively, otherwise she will be stopped by the oar blades backing water at the beginning and end of the stroke. Quickness must not be mistaken for power or strength. Quickness or agility are not at first associated with great

strength; in fact, great strength more often than not impairs agility. With a lively boat running under the crew, the changes of direction at the full reach and finish must be quick and snappy as compared with the more deliberate stroke and recovery just preceding the change.

Get a little more life in that catch, everybody. Don't row any harder, but get what power you put on quickly, — more life in it; and remember that a baby has life as well as a Sandow. Don't try to row harder until you are all sure that you can make every ounce tell. It is well to build up the substance of rowing on the skeleton of form. Some, however, prefer to call form the mould and then proceed to coach substance, as we may call mere physical strength, into it. There is one difficulty, however, that will be found in this latter method, and that comes from the greater strength of one part of the body as compared with another part. Suppose that the legs are very much stronger than the back, and that instead of making the whole muscular system ease up so that the back can do its work and get strengthened gradually, that is, insisting on form from the start, and building substance up on it, — instead of building up, we try to force form upon a would-be oarsman. His strength will push his slide away ahead of his back every time, and he will presently find it diffi-

cult to realize that he is persisting in a fault, and for no other reason than that he or his mentor do not recognize that a chain is weaker than its strongest link. I say weaker than its strongest link, because the natural method of progression is a positive one and from weakness to strength. In this chain one of the links may be called the back, another the legs, and if we are not desirous of getting the cart before the horse, we shall start with some act that the back is perfectly able to accomplish; something that is more nearly a going through the motion,— formal rather than substantial. Thus, with gradual increase of work the weaker link becomes accustomed to progressive effort. Underneath all this there is a knowledge of what the right thing is, a knowledge that has grown logically, a knowledge which makes the man do the right thing naturally.

Very often one sees the man who has had form, as it were, pushed down over him, maintain a fairly respectable showing, but directly the restraint is removed he falls back into all the old faults. In the human activities, as in the human body, we find that plan which builds a substance or body upon an interior skeleton or form is a most satisfactory arrangement. Those exponents of the external skeleton, the snail and the tortoise, while probably adepts in shells, are but slow coaches

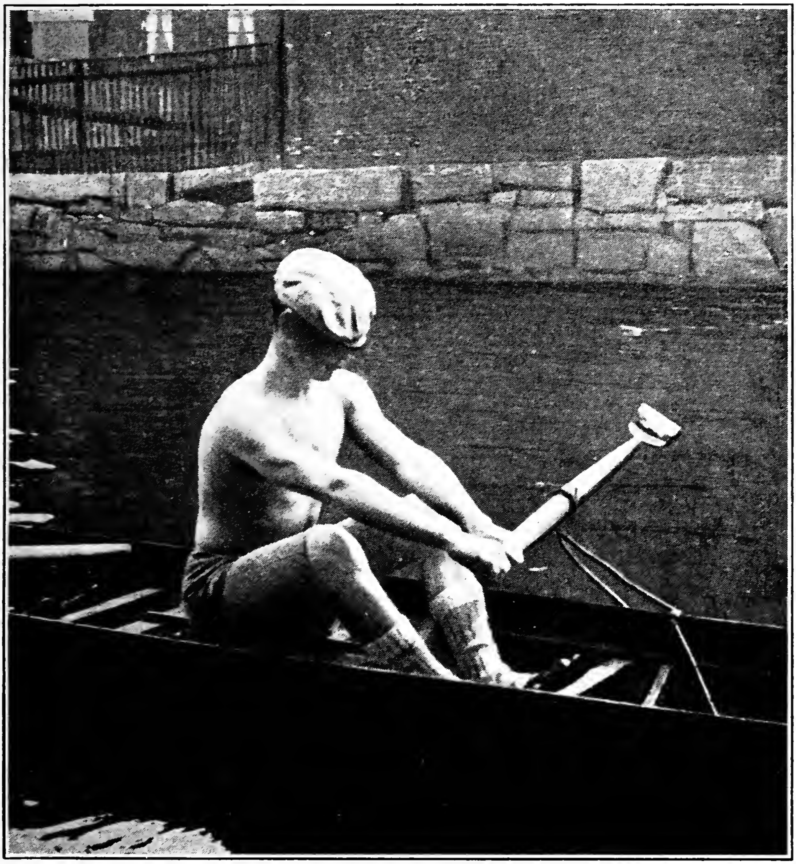
and poor models at best, for even a scheme of rowing.

While on the subject of life or liveliness in the stroke, it is worth while to emphasize this point as an important part of practice rowing at all times. We suggested a few lines back that a baby has life as well as a Sandow. The one simply suggests life or liveliness, the other stands for a fully developed physical life. We have had what corresponded to this in what was called "paddling," and what is still so called in English rowing, as distinguished from rowing with full power. In paddling there was practice, form, life, a sort of playing at rowing, rowing for the fun of it, yet with an object, the acquiring of skill and the getting together as a crew. In rowing, you left out most of the fun and got down to work, but along the same lines as those followed in paddling. If, to use another simile, we thought of an Adonis paddling, we must think of him as developing into a Hercules when the word came to row. The distinction between these two degrees of rowing is one worth bearing in mind. After a crew gets pretty well together, they should practise paddling and rowing alternately, a longer stretch of paddling being followed by shorter, snappy stretches of rowing, care being exercised to have the decided difference one of power only. For, after all, paddling is

but the preliminary canter, and the crew should be given foretastes of what is expected of them in their race, as soon as they get shaken together enough to keep their boat on keel.

You are rushing the slides, all eight. Spend less time sitting on the sliding seat and more time standing on the stretchers. You are slow in starting the recover, first with the hands, then with the body, and last with the slide. As a result there is little else for the crew to do but to make up for lost time, with a dash for the full reach.

Make your dash early, when the speed of the boat is at its highest, and get the feeling firm in mind, that in starting the change of direction,—in starting the recover,—you will use your toe-straps not to help you get back to the full reach, but to start pulling the boat up to a point where you can get a full reach. It is not enough to pull the boat along during the stroke; there is three times as much momentum in the crew as there is in the boat, and this should be used to help the boat along at the beginning of the recover. A shell eight is not a passenger boat at any stage of a race, either during the stroke or while the crew is recovering, and it is a mistake for any crew to turn passengers on the recovery, as if to watch the effect of a stroke while coasting out on the slide for another try. There will be weight enough on



TAKING OFF THE FEATHER PREPARATORY TO BEVELING AT THE FULL REACH. *Page* 75.

(*See also plate facing page* 78.)

the slide to bring it along out to the full reach, try as you will to keep yourselves on and in the stretchers. The instances of a free running slide being left behind at the start of the recover are not numerous and need cause the crew no concern.

The Stretcher

In the rowing, as in almost everything worth doing, we want a fundamental idea or principle to go by, something to tie to, as the expression is; and we have that as soon as we get into the boat, — the stretcher, — and we tie to it, and then, as like as not, go to rowing and forget all about it. Here again is where the beginner in rowing needs more of the "baby" idea in his work. He must remember where his feet are and why they are fastened in. These items seem so rudimentary as hardly to be called for here, and yet if we tell the crew to take off the feather of the oar as the hands pass over the feet, few in the boat will give evidence of knowing where their feet are in relation to their hands. The expression "taking off the feather," above, refers to the turning the oar blade from being parallel with the water to a position perpendicular to the water, ready for the next stroke. The idea in feathering the oar is to avoid the resistance that the perpendicular oar blade offers to the air. It is in line with

the whole scheme of the recovery to steal a march on the boat, to get ready for another stroke without hindering her progress. Reference has been made to the construction of the oar at the point where it rests in the lock. It will have been noted that one side of the oar, where it is in contact with the rigger or lock, is flat. That flat side is parallel to the plane of the blade. It is the flat side that may be called the working base of the oar. That is, the flat side is the side on which the oar is made, or intended to rest for the larger part of the time that it is in motion. There is, of course, no question as to the use of the flat side of the oar during the stroke, unless we consider the occasional oarsman, who finds the round corner convenient to enable him to reach downward toward the bottom of the stream. The flat side, then, during the stroke is pressed firmly against the forward side of the rowlock. The forward side of the lock is so adjusted that it allows a straight horizontal pull to keep the oar blade just covered. It is evident that during the stroke there is no question that the flat side of the oar is the working base and that this flat base is perpendicular. During the stroke the weight of the oar and the strength of the oarsman in pulling it through have been acting horizontally. In fact, we may say that the dead weight of the oar in the lock has been

practically nil. But when the stroke is finished and the oar rests in the lock, and is there carried until the beginning of the next stroke, it should again rest on its working base. This base should now be horizontal, and the oar blade feathered, so that it will require less effort on the part of the oarsman to push it forward to where it is to catch the water. It will also require less lifting to keep it from touching the water during the recovery.

Wind Resistance

If we presume that a crew is rowing on a day on which there is no wind, that crew will be moving at a speed of nearly twelve miles per hour, which means that they must resist a wind blowing twelve miles per hour. The difference in the amount of resistance offered by the oars of an eight when feathered and when carried through the recovery perpendicularly amounts to about five square feet, this being, roughly, the area of the oar blades. With a head wind, or even in a calm, it must be evident that for a crew to neglect to feather its oar blades means that the members must work harder on the recovery to push their oars flat against the wind, that the resistance offered by the oar blades must stop the boat in a measure, and that they are all likely to recover with the blades at different

angles, since there is nothing in the rounded part of the oar to hint at uniformity.

With a following wind the feather loses some of its value, but is still to be used because it enables the oarsman to carry his blade along near the water with less danger of hitting the waves between strokes and brings him near the water at the full reach. It is just at this point that one begins to realize why the carrying of the blade in the position described is called feathering. With a head wind, the air tends to lift the blade as it is being turned to the perpendicular ready for the catch, the blade traveling in the direction of least resistance. To meet this soaring tendency, or "skying," as it is sometimes termed, the blade should be turned from the horizontal to a little beyond the vertical position, just before the end of the recovery, or as the hands pass over the feet. If any skying is done in turning the blade, it can be corrected before the full reach, and the turning of the oar a little beyond the perpendicular will help to bring the blade down into the water, at the very farthest point forward. In this the wind plays a small but not to be despised part, helping to drive the blade down, where but a moment before it was lifting the oar up away from the water.

Beveling

This turning of the blade beyond the perpendicular is called "beveling," or facing the oar. It must be remembered that the bevel, or face, is a part of the recovery, and while it may actually be held until the oar reaches the water, the oar must then come back to the perpendicular so as to rest firmly against the forward pin of the rowlock.

A very practical illustration of the value and the necessity of bevel, and bevel only, may be had if one attempts to row a dory fitted with open tholepins against a gale of wind. To carry the oar blades perpendicularly against the wind is very difficult, while to feather the oars results in their being blown or lifted clean out of the tholepins. The other alternative, to bevel them until it is almost a feathering upside down, enables one to get along in comparative comfort, confining the attention to keeping the oars from being blown down into the water before one is ready for the stroke. In the case of racing boats, there is happily no open tholepin for the oar to blow out from, but there is the large blade to catch the wind, or strike the water during the recovery. One may not always pick his weather for rowing. The crew will seldom have absolute calm for their practice rowing, or their race, and even less often will they

have fair wind to waft them along during an entire afternoon's practice. The crew which adapts its style to the conditions to which it is subject will get more fun out of its rowing, and more speed, than the crew which is too lazy or too mechanical to shade its work to meet the varying circumstances of wind and weather.

Pull it way through, everybody. Get the oars in "out of the wet," and away again before the body breaks from its anchorage at the finish of the stroke. Remember that the best leverage is nearest the end of the oar, and don't imagine the thumb and first finger of the outside hand enough to hold the drive of legs and back, and *don't shift the responsibility of holding the oar all on to the inside hand* merely because it has a more comfortable or permanent grip. The inside hand is valuable and helpful, particularly on the recover, where it feathers and bevels the oar, but on the stroke the outside hand, consisting of the thumb and at least three fingers, should hook strongly round the end of the oar handle, coupling it up with the motive power in legs, back, and arms.

If it is questioned whether the thumb and one finger are inadequate, let the questioner try pulling himself up to his chin on a horizontal bar, using what we may call a hand and two fifths. While he is doing this, let him not fail to observe the position

THE FINISH: A WEAK POSITION. *Page* 80.

of his elbows, and note that they are by the sides, not out at right angles to the body. The lifting of the body in this case involves considerably more of a pull than is required in pulling an oar through in rowing, and it incidentally shows how we go about it when we have a really severe task to accomplish. It shows better than any amount of discussion can, what position in relation to that other horizontal bar, the oar, the arms and hands should occupy during the stroke, if we wish to use our strength most directly and economically. And although we don't have to lift such a heavy weight in rowing, nor could and get very far, still the more power we get in the stroke the faster the crew will go, and we may keep the experience of pulling ourselves up to our chin as a sort of ideal performance or model to go by in pulling an oar.

Overworking the Recover

Remember always what you are doing in the boat, — rowing, — and don't let it degenerate into recovering. A crew that makes hard work of its recovery will have very little strength left to row with. If anything is to be sacrificed, let it be the recover rather than the stroke. If the recover gets to be hardworked, it ceases to be of value even as a recovery. It fatigues instead of rests the crew, and more quickly, because it is a more unnatural

effort than the work of rowing a stroke. When man and his ancestors stood upright, they were able to do so through the use of the muscles of the back. Gravity took care of the forward or downward movement of the body, and as a result the muscles in the anterior part of the body are less adapted to pulling the body forward than the muscles of the posterior regions are to lift the body against the force of gravitation and to hold it upright. Coming back again to rowing, it must be conceded that to be natural, as well as progressive, the stress should be laid on the stroke rather than upon the recovery. And while we have spoken of the use of toe-straps in drawing the boat up under one in recovery, this must not be interpreted as a thing to be done at the expense of undue energy. The idea of stealing a march on the boat in recovering — in getting out to the full reach for another stroke before the boat has had a chance to stop — the idea of stealing should suggest an action carried out on as inconspicuous lines as possible. In fact, everything must be subordinated to the idea of rowing.

Slow and Slowed Slides

It may not come amiss to consider here the difference between a slow slide and a slowed slide. The slowed slide has been considered at some

length earlier in this work. Its underlying idea is that of helping the boat between strokes by pulling her along with the aid of the toe-straps. Further, it is an action which blends with the quick shoot of the hands after the finish. The slow slide attempts no lifting along through the toe-straps. It follows a hard finish and leaves as much of the momentum of the crew in the boat as is possible, and for as long a time as possible. It is plain that to have the entire momentum of the crew remain in the boat, and be part of the boat between strokes, the weight of the crew must travel with and as fast as the boat. It is equally plain that, if the crew is sliding toward the stern, some of the momentum or speed of the boat is lost. The aim, then, of the slow slide is to retain as much of the momentum of the crew for as long a time as is consistent with speed and balance. It is fair to presume that the longer the time spent on the recovery, provided the stroke is not forgotten, the easier it will be for the crew. One more point in this connection — the use of the arms and legs for the final send will be found by some to be easier of accomplishment than the quick use of the toe-straps, and the sudden and somewhat unusual effort required of the abdominal muscles in drawing the boat along momentarily with the toe-straps. Both styles of recover have their

advantages. The slow recover is simple, and as much as possible a one-speed movement, and is only possible when rowing a low stroke. The slowed slide is quite as useful and important in rowing a low stroke as it is essential on a high stroke. It would seem more readily to admit of shading than the slow slide. The slowed slide also fits in with the idea of reaching.

Considering the recover from a mechanical point of view, however, the simpler and the easier we can make it the better. The question, then, is, which slide movement is the simpler, the one-movement slow slide, or the graduated movement called for by the slowed slide. In the course of a two-mile race an eight-oared crew will go through the motion of recovering three hundred times or more. But we must not lose sight of this fact: the crew is *rowing* a race, not recovering. With this in view, it is plain that the simpler and more mechanical the recover can be made, not forgetting the definition of recover, the greater will be the amount of energy left to be devoted to rowing.

The Logic of the Slowed Slide

If the slowed slide does not seem as simple because of its shading the speed of the recover, it is at least logical, and for this reason: The first move in the recovery is what is pretty generally

called the "shoot of the hands." Next is something which corresponds to the shoot, performed by shoulders and slide. If there is to be smoothness of recover, and a blending of the motions of arms and body, the body and slide must start quickly, following in a slightly slower fashion the necessarily quick action of the arms in getting the blade out of the water. The slide, under these requirements, must start quickly, and it is the quick start, therefore, that makes logical the slowed slide. In other words, it is easier to slow down from a quick start than it is to slow down from a slow start. The idea of a slowed slide lends itself more readily to our definition of reach. At the beginning of a reach no great care is necessary, and one may start reaching with a fair amount of speed. But as the object is neared (in rowing this object is the water) care must be taken, and the speed slackened in order not to overreach and chop the oar in at the full reach.

I cannot leave the subject without a few last words on the necessity of keeping always in mind the idea of rowing. It must be remembered that practice makes perfect, but practice in form is not enough. Practice, in the substance of rowing, is of the greatest importance. If this practice looks forward to a race in light racing boats, the sooner the crew gets into a light boat the better. It is

always possible to steady the lightest shell by letting four men hold her on keel by resting on their oars. We do not train the crews of our America's Cup defenders on North River or Rockport stone-sloops. No more should a crew that can handle a shell row in a barge. The way to learn to row a shell, and to be at home in it, is for the crew to get in and row the shell as often as may be. Let substance follow close on the heels of form, and let us bear in mind that form *without* substance, in rowing, is like faith without works.

Mr. R. C. Lehmann well expresses the spirit that should dominate the rowing man, in his poem "Style and the Oar":

"To sit upon a seat,
With the straps about your feet,
To grasp the oar and use it, to recover and to slide,
And to keep the body swinging,
And to get the finish ringing,
And to send the light ship leaping as she whizzes on the tide;

"To make the rhythm right
And your feather clean and bright,
And to slash as though you loved it, though your muscles seem to crack,
And though your brain is spinning,
To be sharp with your beginning,
And to heave your solid body indefatigably back.

. . . .

"To seek your bed at ten,
And to tumble out again
When the clocks are striking seven and the winds of March
are chill;
To be resolute and steady,
Cheerful, regular, and ready
For a run upon the Common, or a tramp up Putney Hill.

"To sink yourself and be
Just a unit, and to see
How the individual withers, and the crew is more and more,
And to guard without omission
Every glorious tradition
That the ancient heroes founded when they first took up
an oar;

"In short, to play the game
Not so much for name and fame
As to win a common honor for your colors, light or dark —
Oh! it 's this has made your crew-man
Such a chivalrous and true man
Since the day that Father Noah went a-floating in the Ark."

VI. SCULLING

MOST of us, at one time or other, have rowed a flat-bottomed skiff, or dory, on a pond or on tide-water. Little thought was required to keep the boat upright, and the oars were only necessary to propel the craft. In a sculling boat all is changed. The craft is designed with one idea, — speed. A full-blown "single scull," as the boat is called, with its thirty feet of length and its one foot width, is a very ticklish proposition. Fortunately for both the beginner and the boat, the former is not usually obliged to start in the narrowest boat. His beginnings should be undertaken in a craft whose width is at least three feet. In such a boat he will rapidly gain confidence and an idea of balance, both of which are essential for a sculler.

CONTROL OF OARS OR SCULLS

The first thing to be borne in mind — to be grasped mentally and physically — is the oars or sculls. It is upon the oars or sculls that the rower must depend, not only for getting ahead, but for even staying in the boat at all. It will be observed that while the sculling boat itself is nar-

row, its oars are long, and really have a wider spread than those of a rowboat. This length of oars at once contributes to speed, and forms a sort of balancing pole, with which to keep the boat upright. We must insist from the start, in our three-foot wherry, that the would-be sculler observe the same rules as in the narrowest shell. The first of these is that he must always have control of his oars. We will suppose that he has, with some one's help, brought his boat down and launched it from the float. Before bringing down the boat he must have first brought down the oars, else his boat will go drifting away while he is up after the oars, or, if the craft is a narrow shell, it will tip over the moment he turns his back. Next, we must shatter the simple rowboat idea: that either oar will do on either side. It won't. The sculls are rights and lefts, or rather starboard and port sculls, and must be put in their respective row-locks, so that when the blade of the scull is perpendicular in the lock, with the hollow side of the blade toward the stern of the boat, the double row of nails which fasten the leather around the oar will be on top. If this arrangement is not followed, the oars will "feather under;" that is, the front edge of the blade will be a shade lower than the back edge when the oar blade is floating flat on the water, and when the boat is in motion this exag-

gerated feathering of the oar will make it catch the water or cause "crabbing," or "catching a crab," as in sweep rowing.

Getting in

Having adjusted the oars or sculls on their proper sides, the next thing is to get into the boat. Face the stern of the boat. Grasp both scull handles in one hand, having the outside scull flat on the water and the inside one resting on the float. Then, standing forward of the rowlock, step into the boat, placing the foot exactly over the keel and on that part of the cross bracing which supports the sliding seat nearest the foot braces or stretcher. Now transfer the weight of the body to the foot that is in the boat and lower the body down slowly to the sliding seat. Often the slide will be at the extreme forward end of its railway, and it is important that before sitting on it the slide be brought close to the heel of the foot on which the sculler stands in the boat. This can be done with the toe of the other foot, or with the hand not engaged in holding the sculls. It is a great strain on a light sculling boat, wherry, or shell, to have a man fall back upon a seat that is at the extreme forward end of the slide, and it is liable to injure the mechanism of the slide, or even to start the planking of the boat. An even, smooth manner of

entering and leaving a delicate craft of this sort must be practised, just as well as an even, non-jerky method of propelling the boat after one is in it.

The broader boats may not need to be handled with quite such care, but the beginner is recommended to practise this care until it is second nature. He will ruin fewer boats and have less upsets to his credit if he does.

Some of the antics that inexperienced men go through, if not destructive of the boat itself, are often very amusing. To see the puzzled look on a tall, sedate man's face after he has seated himself in his boat, arranged his stretcher, and then, and not till then, discovered that his oar handles are under his knees instead of over, and that he must get entirely out of the boat again, can hardly fail to cause a smile. And even if the man who gets into the boat facing the bow means well, he appears somewhat ridiculous, particularly if he tries to be seated in the same observant posture. At these people we may smile, but we have to regret the action of the nonchalant or thoughtless man who steps into a boat without looking and goes through the bottom planking as through paper. It hardly seems possible that if that same man has helped carry his boat down to the float, he can have failed to notice how light the craft was; and if light, why, if not because the material used in the con-

struction was light? Eighth-inch planking, or thinner, makes but an indifferent promenade deck in a sculling boat, especially if the deck at that point is, at the same time, the bottom.

And now, having pushed off from the float, the most important thing to do is to have both oar blades resting flat on the water and the inboard end of the oars close together. It is well to hold both handles in one hand, occasionally, in order to be sure that the boat is perfectly on keel. In this way, too, confidence is more readily acquired. Nothing is more disconcerting than to try to correct a boat that is off keel by leaning the body away from the down side. If a man sits amidships and brings his oar handles together in front of him, he will have leisure to think of his next move. At this point the sculler must remember never to lose control of his oars or sculls, and never to have them out of the water while he is in his boat, unless he is rowing. In the early stages of his practice we may say, that unless he has a broad boat with a keel, he had best stick close to the water with his oar blades at all times, whether sculling or at rest.

An example of the uselessness of trying to balance a sculling boat by moving or leaning the body from side to side occurs to the writer. A friend had, against the advice of those who knew whereof they spoke, taken a sculling boat from the

racks in the boathouse and was pushing off from the float. Hardly had both oars touched the water, and luckily before he had attempted a stroke, than his boat rolled down until the inboard end of one oar rested on the gunwale of the boat, while the other oar handle was on a level with the man's head. In this position, or rolled over on the other side when he succeeded in leaning far enough off keel to throw the boat into the alternative position, the would-be sculler drifted away from the float and from the shouted gibes and suggestions of his comrades. A quarter of a mile farther down stream the now pretty well rattled rower encountered another floatful of men with suggestions pertinent or personal. These, or the fact that there was no good landing below this point, brought the incident to a close. The writer's friend swam to the float, and his boat, strained and broken by the unusual handling, was taken to the repair shop. Not once during that drift down stream had the man brought the oar handles together or kept them on a level. It did not occur to him in the ten minutes or so that he was vainly trying to solve the problem of balance that *to raise or keep almost anything up one must lift.* The boat depended on the oars for being kept up. To correct her being off keel, then, required that the down side be lifted by means of the oar on that side. This is easier said than done, it will

be contended. The same topheaviness exists in every narrow sculling boat and has to be met in just this way by one who would scull. With experience, however, comes the ability to meet and check this tendency of the boat to roll at its very first sign.

The Stroke

Taking for granted that the sculler is now able to sit quiet in his boat, oar handles together, and therefore level, or at the same height above the knees, he should try to take a short stroke, — and by a short stroke is meant one that only requires the bending of the arms and the drawing in of the hands to the body. Even with this first short journey of the hands, the lifting spoken of above will have to be brought into action now on one side, and immediately on the other, to prevent the first lift from carrying that side of the boat too high. If it does not seem desirable to carry this analysis of the means used in maintaining the balance so far, let it be remembered that, as the handles of the oars separate in drawing the stroke through, they must still be kept on a level.

It is advisable in the first attempt in a sculling boat to move the oars very slowly backward and forward in unison, without turning the blades perpendicular, as in rowing. In this way the rower may get accustomed to the simple act of balancing

in every position from full reach to finish, and throughout the recovery. By keeping the blades flat on the water, during these first movements, the maximum support will be had from the oar blades, and by moving the oars slowly, particularly when pulling them toward the body, the beginner will avoid having the blades cut under.

It is not a bad plan for the sculler's early efforts to be directed to sculling with such motions as can be had with arms and back, leaving the legs and slide at rest, and giving the body a firm base from which to work.

Look out Ahead

One of the necessary evils of sculling is that of looking over the shoulder every dozen strokes or so to be sure that one's course is right, and to make sure that there is no obstacle or floating menace to the frail boat. Therefore it will not be amiss to practise with first one oar, and then the other, turning the head to watch the work from full reach to finish, and accustoming one's self to rowing with the head and chin over one shoulder or the other. It will be of great assistance, too, to see what to do and how to do it, for, as in sweep rowing, all the motions are reversed, and to be able to watch the blade for a time will lead to an earlier mastery of what is required.

Body Work

As regards body swing, it must be remembered that the pivot is to be kept low. The arc described by the swing of the shoulders forward and backward should be swung from the upper side of the sliding seat, not from the small of the back. So, then, if justification is needed for beginning work without using the slide in a sculling boat, it lies in the limbering up that the back gets from having to do all the work.

The beginning of the stroke in sculling requires that the body be inclined well over the knees, that the arms be straight, and that the blade be perpendicular in and just covered by the water. More constant care must be given to having the blade absolutely perpendicular, before taking a stroke in a sculling boat, than was necessary in an eight. The sculler has both sides of the boat to look out for, while the sweep oarsman had but one, and he was only responsible for a quarter of that side.

Gather-catch

The fact that the sculler has to attend to both sides of his boat leads to a style of sculling that differs slightly from the hard, quick catch practised by sweep oarsmen. The sculler must first

make sure and then go ahead; that is, he must scull with a stroke that begins easy, and increases as he feels that everything is all right. If checking the progress of the boat is to be avoided, there must be smoothness; and here, at least, we have a catch that more resembles a gather; not that the oars should hover over the water at the full reach, but that after they are buried an increasing application of power sends the boat ahead, rather than the quick, hard catch that was necessary in the eight, if the crew was to keep ahead of the boat's pace on the catch. A single shell has not such speed as an eight, and in consequence requires or allows of a slower catch. Further, the balanced rig of a sculling boat allows a longer reach and a longer stroke all through than sweep rowing. This excess of reach and finish does not necessarily mean a longer effective stroke, for it is possible to reach so far as merely to press the water out at right angles with the course of the boat at the full reach and to press the water in toward the boat at the finish of the stroke. But the long forward reach does allow the sculler to get his oars well covered, his boat well balanced, so that as he comes to the middle and latter effective part of the work he is sure to have his boat in such perfect balance that he can put every ounce of power into the middle and last of the stroke.

Again, at the end of the stroke the oar handles may pass the body instead of stopping at it, as with sweeps. Here, again, length may not mean power, but it may mean adjustment of balance, and the fact that the oar handles clear the body allows the latter to remain more erect, or even to start forward before the hands and arms have entirely completed the stroke.

In outrigged sculling boats it is usual to have one outrigger a little higher than the other in order to allow one hand to be over the other, half-way through the stroke, without throwing the boat off keel. In other words, if the hands were level at the full reach, or equidistant from the water, and the boat on keel at the same time, the middle of the stroke would find the boat off keel, because the overlapping of the oar handles requires that one hand be under the other. An alternative for this crossing of the hands in mid-stroke consists in pulling one oar through just ahead of the other, and on the same level. This obviates the necessity of rigging a boat for right or left hand over. The difference in height of riggers, however, is so slight that it is perhaps best to be rigged for one hand over. Such rigging will not interfere with pulling the stroke through with one hand behind the other and, on the recover, right or left over may be a very convenient style of rigging.

Hindsight

A few words of caution on the subject of keeping a lookout ahead every few strokes, particularly on tidal waters or where there is much rowing. A shell boat is a thin-skinned affair, and will stand little or no battering. A floating barrel does little to advertise itself, particularly when one is rowing toward the setting sun. The glittering pathway up which one is sculling is trying to the eyes, but it must be scanned, and often. The writer's own experience as he was returning from an afternoon's row will serve as an illustration of the futility of depending on even one careful look before rowing, — say quarter of a mile. He was returning to the float, and having about an eighth of a mile straight going against a low dazzling sun, decided to make it in one hard stretch. The course was clear. There was nothing between him and his destination, as far as could be seen. He started on a quick sprint to cover the distance. Half-way home there was a crash; the writer turned a back somersault out of his boat, as she stopped suddenly, and when he came to the surface he found the obstruction was a double scull, in which sat two very scared men. His own boat had struck theirs just aft of amidships and had gone completely through her, just grazing the foot of the stroke oar.

Another incident of collision where the bow of one boat penetrated another shell and passed through between the tendon and the ankle-bone of the other oarsman, necessitating the latter's having to be sawed out of his boat when rescued, is a gruesome classic in Charles River lore. Instances might be multiplied, and it is even reported in a neighboring city, where rowing is much indulged in, that the channel buoys have been known to sink from the weight of metal punched into them from the bows of many indifferently steered racing shells constructed with copper tips on their stems.

It is another case where "eternal vigilance is the price of liberty." Hindsight is better than a long swim to a boat builder's, particularly if one's specialty be rowing and not swimming. If a man will not bring himself to keep a watch out for his course ahead, let him take up canoeing.

Of boats, oars, and rigging, little has been said. The beginner is not so very much concerned with the refinements of the mechanical details. When he does get interested in these things he will go into the detail of the thing very much deeper than it is the purpose of the writer to go here.

VII. THE COACH

WE may not close without a few words to the coach. He must have patience. He must be impartial. The captain may need as much criticism as any one else, and he should get it. The coxswain will learn more if he is told what to do and is sent out in a single scull to learn the effect of the oars on a boat, instead of sitting around all the afternoon with a box of cigarettes waiting for his crew. The coach should be able to practise as well as preach. His criticism should be positive and constructive, rather than negative and denunciatory. He should suggest a cure or the proper way, rather than dwell on the fault. "Just cover the blade" is better than "Don't dip so deep," for it tells how to do it definitely. "Don't dip so deep" leaves a perfectly definite opening for the framing of such a question as "Well, how deep shall I go?" by the man out beyond the big end of the coach's megaphone. The coach must remember that the oarsman is working along physical lines, and developing, for the time, in body rather than in mind. Therefore, the coach should try to put his suggestions in ways that are likely to catch

the attention and fix themselves in the oarsman's mind. A few years ago the writer, boated, was some distance out beyond the big end of a megaphone. The coach could not seem to get the two crews to avoid a bad hang at the full reach. At last he thundered out, "You fellows are so slow in getting in at the full reach that a hen could go to roost on your oar handles out there." It would have been a lively hen that could have gained foothold on any of the sixteen oars after that challenge from the launch.

And so it must be remembered that while he is working to make human beings approximate mechanical perfection, the mechanical is reflected in a decreased mental activity, and the coach must be doubly keen to detect signs of overwork and to act on his own initiative when such signs appear, without worrying the subject or without submitting him to questioning as to how he feels. His rowing, his general demeanor, his appetite, should be as an open book to the coach. The man, more often than not, will conceal his feelings lest an expression of them prejudice the coach against him. Intuition, therefore, is one of the most important requisites of a good coach.

The best oarsmen do not of necessity make the most skilful coaches at the start, for they must learn to see. It was theirs to do what they

were told or coached to do. Their work was physical in large part, and they went ahead on the path that was outlined for them. When they come to coach others and endeavor to describe what is wanted, the difficulties begin, and can only be overcome with persistent study. Study means time, and in our American lexicon "Time is money." Here, then, is the reason why the professional coach is a logical outgrowth of American institutions and temperament; and until Americans can afford to approximate more nearly to something of the play spirit of our cousins over sea we shall continue to look to specialists for the keenest development in any line of endeavor, — work or play.

THE EFFECTS OF TRAINING

A STUDY OF THE HARVARD UNIVERSITY CREWS[1]

INTRODUCTION

THIS investigation was undertaken at the suggestion of the Harvard Athletic Committee, by whom it was felt that a knowledge of the physiological changes occurring during severe training would be of value, and that incidentally data might be obtained throwing light on the obscure subject of over-training. It is intended to make a similar study of the effects of training for several other forms of athletic contests besides rowing, especially football and running. Since no similar research had, as far as known, been attempted, this first series of observations on the effect of rowing was regarded as tentative. It was doubtful how far the subject would lend itself to study, and hence it was thought best not to attempt too much until

[1] Boston Medical and Surgical Journal, cxli, 9, 10, cxliv, 23.

the more promising lines on which to work had been determined. Much of the work has been somewhat barren of result, while in other directions unexpected facts have been learned and the necessity for further study revealed. For example, it early became apparent that one of the most important parts of the investigation would concern the nutrition and tissue metabolism, but for want of suitable apparatus and in the absence of a chemist to analyze the food and excreta, this part of the work was done only in the most superficial way. It is hoped that a subsequent investigation will include a much more complete study of these important points. The greater part of the work which was thought to be feasible this year was a study of the changes taking place in the heart and kidneys, and a series of observations on the weight and temperature and their relation to the general condition of the men. The observations covered the months of May and June, and hence included only the more strenuous part of the training period, for which all the men had been prepared by long preliminary work, as detailed below.

There were certain difficulties which limited the scope of the inquiry and which must be borne in mind in estimating the results obtained. The chief one was the impossibility of maintaining constant supervision over the men, and the conse-

quent loss of much valuable information. This was not true, however, during the two weeks at New London, where the opportunities for observation were excellent. A second difficulty was that circumstances sometimes compelled the use of cruder methods of examination than would be necessary for the most accurate work. For instance, the most accurate method of determining the size of the heart and the method least liable to error from the "personal equation" is by means of the fluoroscope, but owing to the impossibility of setting up an elaborate X-ray machine at New London, one had to fall back on the less certain method of combined auscultation and percussion aided by the phonendoscope. A third limitation to the inquiry was the obvious one that all the observations had to be arranged so as not to interfere in any way with the main objects of the training, which were to learn to row and to get into the best possible condition. Consequently, nothing in the way of experiment could be attempted, nor any examination which would fatigue the men or distract their attention from their rowing.

These limitations were unavoidable, but were counterbalanced in a way by the active co-operation of the coach and of the individual members of the crew. Their courtesy and interest were unfailing, and alone made it possible to carry on

the observations, involving as they did a considerable expenditure of time and a certain amount of irksomeness.

Preliminary training. — The large number of candidates who began training in the winter were gradually weeded out by a process of natural selection, based on numerous trial races, until but sixteen remained. These men were organized into two crews in April, and practised daily until early in June. Shortly before going to New London a new man was taken from one of the Weld crews and five of the squad were dropped. The remaining twelve comprised the two crews — the eight-oar and the four-oar — which took part in the races, and most of the statistics of this paper refer to them. The observations on the five who stopped training early in June were eliminated, so that more correct comparison could be made.

Of these twelve men all had done considerable previous rowing in their class crews or in the Weld crews. Four had rowed on former Varsity crews, and one had been a substitute. Several had begun rowing in preparatory schools. Six out of the twelve had played football, and two had practised running. The period of active training for these sports had been from two to six years, so that all the men may fairly be called trained athletes, and the changes effected by training would not be

expected to be as marked as in the case of inexperienced men.

The previous health of all the men had been good with one exception, who gave a history of typhoid six years ago and rheumatism a year later.

General statistics.—The following table gives in brief the ages, weights, heights, chest and abdomi-

TABLE I

No.	Age.	Weight May 8–17.	Height.	Chest measurements. In-spiration.	Chest measurements. Ex-piration.	Chest measurements. Ex-pansion.	Circumference of abdomen.	Vital capacity.
			Ft. In.	In.	In.	In.	In.	Cu. In.
1	20	165	5 9	41	35	6	31	235
2	20	158½	5 11½	38	34	4	29	290
3	20	175½	5 9½	41	37	4	33	330
4	20	180	6 1½	39¼	35	4¼	31½	330
5	21	177½	6 2	40¾	37¼	3½	32¾	380
6	19	178	6 2½	39¼	33¾	5½	31	330
7	24	167½	6 1½	37¾	33¾	4	30	330
8	21	163	6 1	39¾	34½	5¼	31	350
Av'ge of eight	20⅝	170⅝	6 0¼	39⅝	35	4⅝	31⅛	334
9	20	159½	5 8½	38	34¾	3¼	31½	295
10	21	176	6	42	37	5	33	380
11	21	170	5 10½	38¼	34¼	4	32	260
12	22	157	6	39¼	34¾	4½	31	290
Av'ge of four	21	165⅝	5 10¾	39⅜	35$\frac{3}{16}$	4$\frac{3}{16}$	31⅞	306
Av'ge of squad	20¾	169	5 11¾	39½	35	4½	31½	325

nal measurements, and vital capacities of the lungs of the individual members, with averages for the eight and four, and, finally, the averages for the entire squad:

I. GENERAL SKETCH OF THE TRAINING

Daily rowing. — During May and the first ten days of June the daily exercise consisted of rowing on the Charles in the latter part of the afternoon. The distance covered varied according to circumstances from five to eight miles, occasionally more. At New London there was added a short morning row of two to four miles. Between the middle of May and the race there were five time-rows, — three on the Charles of three and three-eighths miles each, and two on the Thames over the four-mile course. These time-rows were designed to accustom the men to rowing long distances at high speed and to enable the coach to judge of their form and endurance, but incidentally they afforded excellent opportunities to study the effects of long-continued exertion, and were, moreover, striking demonstrations of the effects of training. The earlier time-rows, though shorter than the later ones, were much more exhausting, and their effects on the hearts and kidneys — the organs showing most evidence of strain — were considerably greater.

For the purposes of this inquiry, however, the time-rows had to be regarded as factors disturbing the regular process of development which might be expected were the daily exercise uniform or slowly increased, and hence it became necessary to divide the observations into two parts, the first directed to the changes in the daily condition, eliminating the facts of the time-rows as far as possible, and the second directed to the immediate effects of the time-rows.

Diet. — The diet allowed was a very generous one, consisting of a hearty breakfast at 7.30, lunch at one, and dinner after the evening row. For breakfast the fare consisted of fruit, oatmeal or shredded wheat, eggs, some form of meat, bread and butter, potato, and milk. At noon there was cold meat, potato, bread and butter, marmalade, preserved fruit, and milk. Dinner comprised soup, occasionally fish, roast beef or some other hot meat, several vegetables, bread and butter, and a simple dessert. No tea or coffee was allowed, but ale or claret was permitted at dinner, also water in small amounts as desired. During the last week before the race each man received a dish of calves'-foot jelly with sherry wine after the morning row, and a light lunch of oatmeal, milk, and bread was served at four o'clock in the afternoon.

Sleep, bathing, etc. — The ordinary allowance of

time for sleep was nine hours, — from ten to seven. General plunge baths were prohibited, but after rowing the men were allowed a cold shower bath in Cambridge and a bucket bath (for want of a shower) at New London.

Besides rowing, the men indulged in very little exercise. While in New London a five-minute walk before breakfast, an occasional game of quoits or spasmodic efforts to play baseball, were the only other forms of exercise indulged in. When not rowing, sleeping, or eating, the men passed the time in reading, writing, or in pure and simple loafing.

II. EFFECTS OF TRAINING

Weight. — It has long been recognized by athletic trainers that the weight is one of the best indicators of condition. The average weight of the eight men constituting the crew from May 18th to June 29th is shown in Chart 1.

During the first ten days of this period there were no marked variations, and in spite of two hard time-rows the average on May 29th was exactly the same as on May 18th, 171.4 pounds. Beginning May 30th, when there was a third time-row, there was a steady fall in weight for a week. The weather at this time was very hot and oppressive,

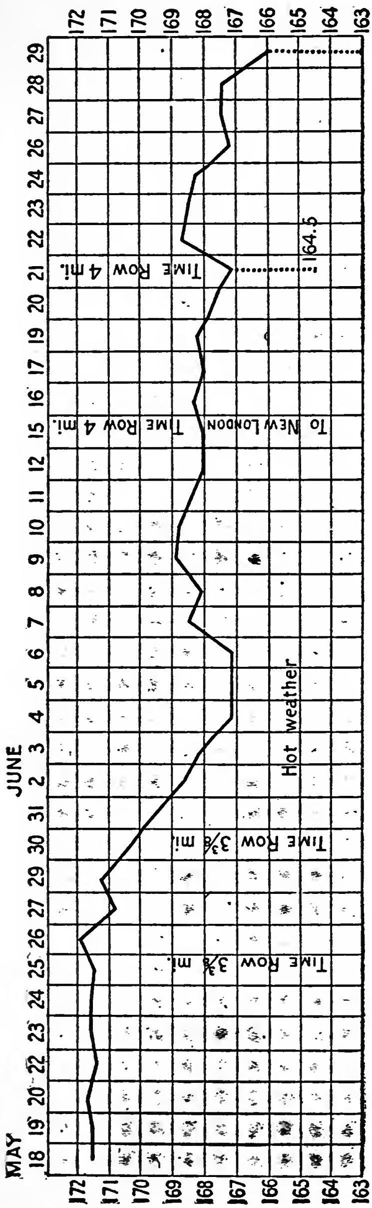


CHART I. Average Daily Weight of Varsity Eight.

and owing to the fact that the crew rowed for a few days on Spy Pond, Arlington, there was much delay in getting dinner. These two factors, added to the hard work the men were then doing, contributed to the fall in weight. From June 6th until the day of the race the average was very constant, fluctuating between 167 and 169 pounds, although individuals showed more or less variation. Losses in some men were usually balanced by gains in others. Chart II illustrates the range of variation in three of the crew. In the case of No. 7, whose condition was uniformly good, the variation was slight, and, leaving out of consideration the sharp fall during the time-row and race, amounted to but three pounds. In Nos. 6 and 3, on the other hand, the range of variation was ten and eight pounds respectively. No. 6 began hard training in April, and was somewhat slower in getting down to his normal training weight than the others. The sharp fall in No. 3's line between May 30th and June 2d was accompanied by some insomnia and general malaise, but unfortunately he was not under immediate observation at the time. One of the commonest causes of fluctuation in weight was diarrhea. In several instances slight attacks caused a fall of three or four pounds in twenty-four hours, though in every case this was quickly restored soon after the diarrhea ceased.

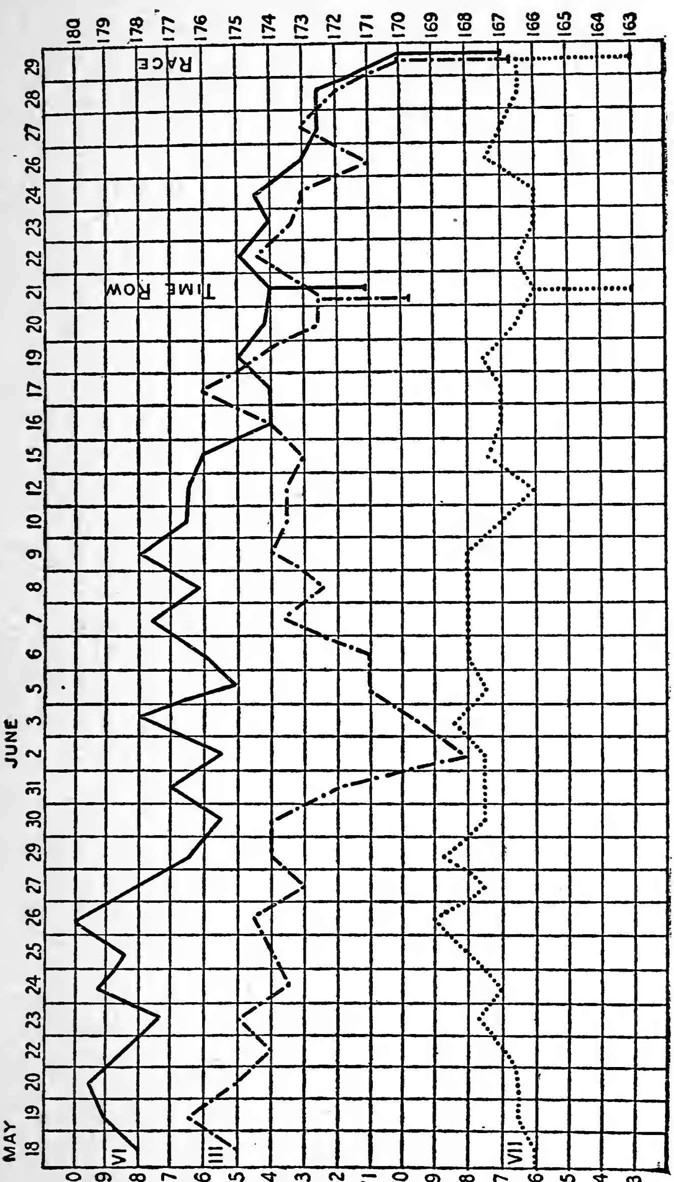


CHART II. Weight Chart of Nos. 3, 6, and 7, showing Daily Variations.

TABLE II. LOSS OF WEIGHT IN TIME-ROW OF JUNE 21ST.

	1	2	3	4	5	6	7	8	Total.	Av'ge.
Preliminary loss	1	1	0	1	1	¼	½	1½	6¼	¾+
Loss during time-row	1¾	2½	2¾	4	2	2¾	3	2	20¾	2⅝—
Total loss . .	2¾	3½	2¾	5	3	3	3½	3½	27	3⅜

TABLE III. LOSS OF WEIGHT IN RACE, JUNE 29TH.

	1	2	3	4	5	6	7	8	Total.	Av'ge.
Preliminary loss	2	1¾	2¼	¼	1	2½	0	2½	12¼	1½+
Loss during race	2½	2	3¼	3	2	3	3½	2¾	22	2¾
Total loss . .	4½	3¾	5½	3¼	3	5½	3½	5¼	34¼	4¼+

Tables II and III show the effect of the last time-row and of the races on the weight. The preliminary loss means that which is always noticed during the twenty-four hours before a race. It may be attributed to nervousness, affecting the appetite and urinary secretion. This preliminary loss, as might be expected, was considerably greater before the race than before the time-row, being 12¼ and 6¼ pounds respectively, while the actual

losses during the time-row and race were nearly the same, — 20¾ and 22 pounds respectively.

Through an oversight, the weights of the Varsity four-oared crew were not recorded during the last two weeks of training. A comparison of their weights immediately before and after the two-mile race showed an aggregate loss of 13 pounds, averaging 3¼ pounds.

Compensating for the rapid loss before and during the time-rows and races, there was noticed, after those events, an equally rapid recuperation; this is shown in Table IV, in which are given the total losses and corresponding gains for the time-row of June 21st. Every man recovered all or more than he had lost inside of twenty-four hours.

TABLE IV. TWENTY-FOUR-HOUR GAIN AFTER TIME-ROW OF JUNE 21ST.

	1	2	3	4	5	6	7	8	Total.	Av'ge.
Total loss . .	2¾	3½	2¾	5	3	3	3½	3½	27	3⅜
Gain in 24 hours	4¼	5	4¾	5½	3¼	3¾	3½	3½	33½	4 3/16
Net gain . .	1½	1½	2	½	¼	¾	0	0	6½	13/16

A loss of several pounds during prolonged exertion does not by any means imply an undue

degree of exhaustion, provided the individual is in good condition. The men who lost most were in fully as good condition as their companions, both before and after the race. It is generally accepted on experimental grounds that during active exercise the energy is largely, if not wholly, derived from the oxidation of fat and glycogen, and that the muscles themselves are not used up in the process. The end-products of this combustion — chiefly water and carbon dioxide — are rapidly excreted through the lungs and skin. The loss of weight represents very closely, therefore, the amount of fuel used up. Hence, the man who has an adequate supply of reserve fuel in the form of fat and glycogen is in better condition to withstand a prolonged exertion than one who is deficient in those substances. This corresponds with the experience of all athletes. There is always a loss of weight during the early part of training, while a man is getting rid of superfluous fat, but every athlete knows that when a certain point is reached, — his so-called "weight in training," — any further reduction is accompanied by a feeling of lassitude and an incapacity to sustain prolonged exertion without excessive fatigue. This form of overtraining, known as "staleness," is in all probability due to a deficiency of reserve fuel. These facts emphasize the importance of maintaining at a

proper proportion the fat and carbohydrate constituents of the diet instead of sacrificing them for an excess of nitrogenous material,— a mistake which is undoubtedly often made and which will be discussed more in detail later.

Temperature.— The temperatures were taken in the mouth twice daily, at 8 A.M. and 9.30 P.M., during the last two weeks of training. The chief points brought out by the routine readings were the great variations in individual cases and the persistent tendency to subnormal temperatures. The average for the entire squad remained near 98° F., as shown in Chart III.

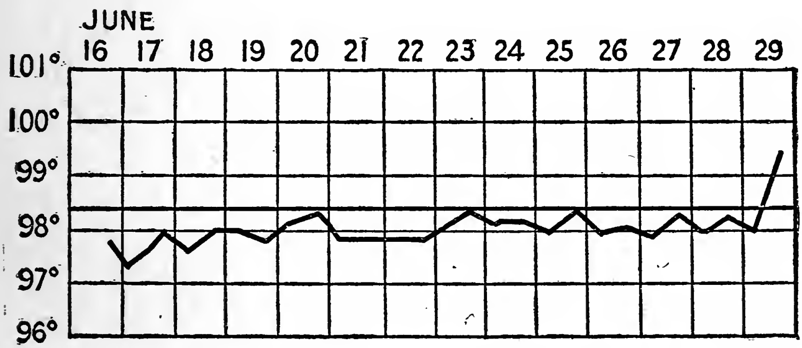


CHART III. Temperature Chart of Entire Squad.

A few individuals maintained approximately a normal average of 98.5°, but the majority showed wide variations. It was not uncommon to find a temperature of 96° in the morning and 98° or more

in the evening in the same man. Charts IV and V are fair sample charts.

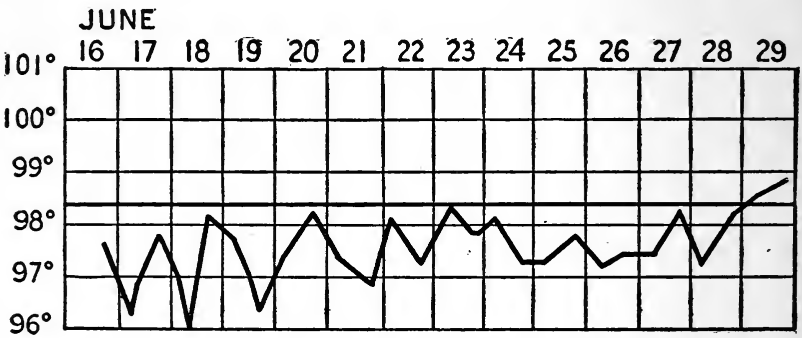


CHART IV. Temperature Chart of No. 8.

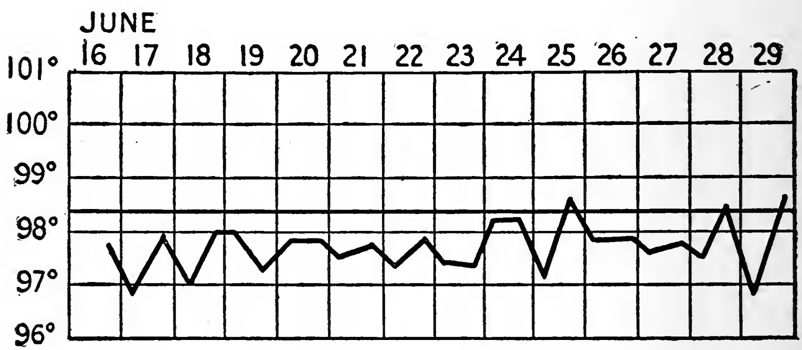


CHART V. Temperature Chart of No. 4.

The individual variations could not be shown to have any definite relation to the general condition beyond the coincidence that those men who varied most in weight also varied in temperature. The body temperature is dependent on so many circumstances that variations within limits are to be

expected. The heat production during muscular and other metabolic action is constantly balanced by the heat loss in warming the expired air, the urine and feces, by evaporation of perspiration, and by conduction and radiation from the skin. During training the greater part of the heat production by muscular action (supposed to be its main source) is confined to a comparatively brief portion of the twenty-four hours, and during the same portion the heat loss is also great. It is not surprising that the heat balance is not stationary and the charts show that in fact in the majority of cases it is not maintained at a fixed point.

On the day of the races the temperatures were taken three times: first, at 8 A. M.; second, while the men were dressing for the race; and finally, from ten to fifteen minutes after the race while returning to the quarters in the launch. There was an average preliminary rise in temperature, corresponding to the preliminary fall in weight, amounting to about 1.5° F., followed by a slight rise of .2° during the four-mile race. In the case of the four-oared crew the average preliminary rise was .7° and a further rise during the two-mile race of .7°. A glance at the Table (V) shows that on the whole those men who had the greatest preliminary rise had either a stationary or falling temperature during the race (Nos. 2, 4, and 5). The other

TABLE V. VARIATION IN TEMPERATURE DURING RACES.

	Varsity Eight.								Varsity Four.				Average of 8.	Average of 4.
	1	2	3	4	5	6	7	8	9	10	11	12		
Temperature at 8 A.M.	97.8	97.7	98.3	96.6	97.6	99.0	99.0	98.6	97.0	98.4	98.3	98.4	98.1	98.0
Temperature before race.	99.2	100.0	99.2	98.6	99.7	100.6	100.2	98.9	97.2	98.7	99.8	99.2	99.55	98.73
Temperature after race.	100.7	98.7	100.3	98.7	99.4	100.6	100.2	99.2	99.8	98.4	100.2	99.3	99.73	99.43
Preliminary rise.	1.4	2.3	0.9	2.0	2.1	1.6	1.2	0.3	0.2	0.3	1.5	0.8	1.5	0.7
Variation in race.	+1.5	−1.3	+1.1	+0.1	−0.3	0.0	0.0	+0.3	+2.6	−0.3	+0.4	+0.1	+0.2	+0.7
Total variations.	+2.9	+1.0	+2.0	+2.1	+1.8	+1.6	+1.2	+0.6	+2.8	0.0	+1.9	+0.9	+1.7	+1.4

extreme was seen in No. 9, who had a preliminary rise of only .2° and a rise during the race of 2.6°. In several instances the net variation was very slight.

It was hoped that the temperature observations would throw some light on the remarkable results obtained by Drs. Williams and Arnold in their observations of the Marathon runners.[1] They found a uniform drop during that race (a 25-mile run) of 2° to 5½°. That race, however, was run in the middle of April at a temperature of 44° F. and against an easterly wind, — the conditions all favoring rapid cooling by conduction and evaporation. Furthermore, the temperatures were all taken in the mouth, and after nearly three hours of rapid breathing of air at 44° F. it is not unreasonable to assume that the mouth cavity may have been cooler than the body generally. One cannot accept as proved their assertion that after prolonged exertion the temperature is invariably lowered. It is the same with their implication that a subnormal temperature during training means "staleness." The idea was apparently based on the single observation that the temperature of one of the contestants was 97.5° before and 97° after a practice run; that the man was advised to rest and to partake of

[1] Philadelphia Medical Journal, iii, 1,233.

more carbohydrates; that on the morning of the race his temperature was 98.2°, and finally that he was among the winners. This observation proves nothing except that a rest and some carbohydrates are good things before a race. The temperature variation was quite within normal limits. If subnormal temperature means over-training, then nearly every man in the Harvard crew squad was overtrained at one time or another during the last two weeks before the races, a statement which certainly would not be borne out by the other facts in their condition, nor by the vigor which they all displayed during the last time-row, and especially during the races. The rise of temperature observed just before the races certainly did not mean a rapid recovery from a condition of "staleness," but simply indicated that for some reason, probably a nervous one due to excitement, the heat production was greater than the heat loss. During the boat races, which were rowed on a clear, sunny day at a temperature of about 80° F. and low humidity, the conditions were favorable for rapid heat loss by perspiration and radiation, so that the excessive heat production which, according to all physiological experience, must have taken place was readily dissipated and the temperature balance maintained. On the whole, we must admit that a subnormal temperature, while of possible significance,

cannot yet be regarded as a positive proof of over-training.

Circulatory system. — Periodic examinations of the heart and pulse were made, special attention being given to the size of the heart, to the occurrence of abnormal sounds, and to the rate and character of the pulse. Examinations were also made after several time-rows and both races.

Inspection of precordia, etc. — All of the men showed a prominence of the precordial region and a more diffuse pulsation than normal. The apex beat, when visible, was usually located in the fifth intercostal space, just inside the mammillary line. After the time-rows and races the apex beat was visibly displaced to the left, and in many instances a marked precordial and epigastric pulsation was noted. There was also in most cases visible pulsation in the peripheral arteries, most marked in the subclavians and carotids. The color was uniformly good, there being no instances of noticeable pallor or cyanosis, in spite of considerable disturbance of the heart's action in some cases.

Size of heart. — The routine examinations were all made in the middle of the afternoon, before rowing, so that the hearts might have recovered as far as possible from the rowing of the day before, and might be taken at their minimum size. Further examinations were made after the time-

row of June 21st and after the races. The method pursued was as follows. The heart sounds were first examined and the apex beat located with the man standing. The man then lay flat and the apex beat was again located by sight and auscultation. Then, by combined auscultation and percussion, using the phonendoscope, the right, left and upper borders were found and outlined. The method is open to objection, as already stated, but seemed to be the most accurate under the circumstances, and by considering averages it was hoped that individual errors might, to a certain extent, be eliminated. The outlines were transferred to tracing cloth, the position of the nipples marked, and the chart then made was kept for comparison. In measuring variations it was found that two fixed lines were necessary, one connecting the nipples — the intermammillary line — and the other bisecting the first at right angles — the median line of the chest. The ordinary terms employed clinically giving the position of the borders in relation to the sternum, ribs, or nipples, are so variable in different individuals that no mean can be determined. The position of the apex beat was measured both from the median line and the intermammillary line; the right and left borders were measured from the median line, the former at the level of the nipples, the latter at the apex. The upper border was

measured from a line drawn through the apex parallel to the intermammillary line. By averaging these various measurements it was easy to construct a chart representing the average heart of the squad, and also to estimate the average variation.

The following Table (VI) and Chart (VI) give the measurements and variations of the average heart of the entire squad. They show that there was a progressive enlargement affecting both sides of the heart during May and reaching its maximum early in June. After this there was a considerable shrinkage, especially of the left side, both the left border and the apex beat receding towards the median line until their positions were not very

TABLE VI. AVERAGE HEART MEASUREMENTS OF SQUAD.

Dates of examinations.	Men examined.	Apex beat.		Right border.	Left border.	Total breadth.	Upper border.	
		From median line.	From intermam. line.				At middle point.	At quarter point.
		cm.	cm.	cm.	cm.	cm.	cm.	cm.
May 9–17 . .	11	8.5	4.5	3.9	12.0	15.9	5.6	3.9
May 18–26 . .	11	9.0	4.4	5.1	12.8	17.9	6.6	4.4
June 2–8 . . .	12	9.7	4.9	6.0	13.2	19.2	6.0	3.8
June 17	12	9.9	5.3	5.7	12.9	18.6	5.0	3.2
June 29 before race	12	9.5	5.0	5.8	12.3	18.1	5.5	3.8

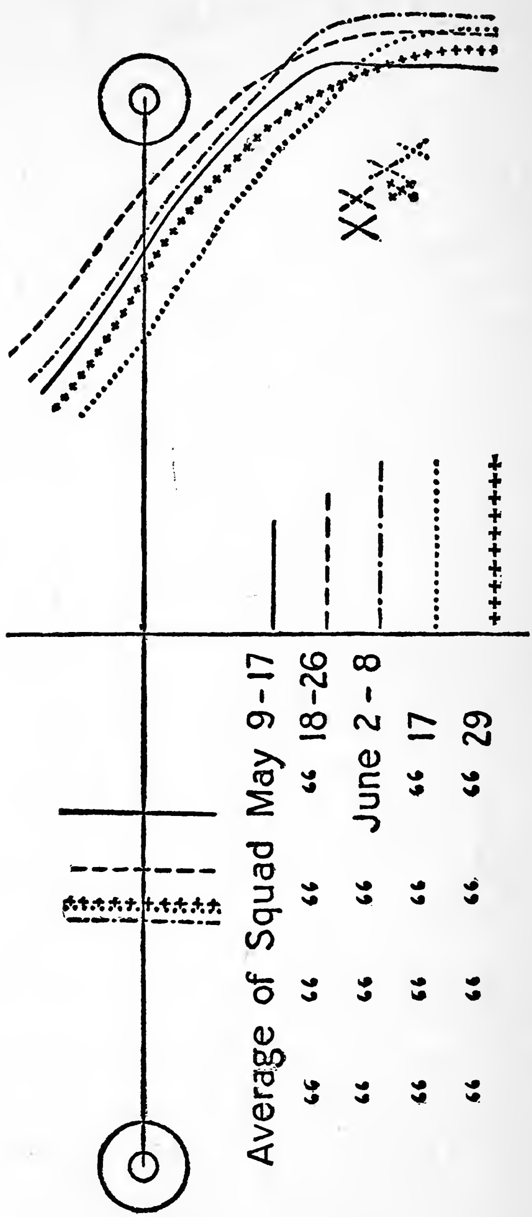


CHART VI.

different from those of early May. The right side of the heart also showed shrinkage, but to a less degree than the left. The position of the upper border varied considerably in the different examinations, depending apparently partly on the fulness of the stomach and partly on the depth of respiration. The relative rise and fall of the apex beat could not be followed as closely as its lateral movement, owing to the ribs.

The period of the greatest enlargement corresponded to the period of the most arduous work, late in May and early in June, when the final selection of men was being made, and when consequently every man was pulling his hardest. Probably the individual strain was greater at this time, because the crew had not yet learned to pull as a unit. Then, too, as already mentioned, the weather was very unfavorable, and the effort required to do the work was considerably greater than was needed later. The better weather conditions prevailing at New London, the more uniform rowing as the form of the crew was perfected, and the more accurate adaptation of each man's rigging to his peculiarities, — all tended to lessen the strain on the individual oarsman, and, by enabling him to do his work with less muscular effort, proportionately diminished the labor demanded of the heart.

How much of the enlargement was due to hypertrophy and how much to dilatation is difficult to say. Probably there were both hypertrophy and dilatation. The accompanying change in the heart sounds in certain cases to be described later would indicate that there was considerable dilatation at first, but that subsequently the hearts gradually recovered tone and a true compensatory hypertrophy took place.

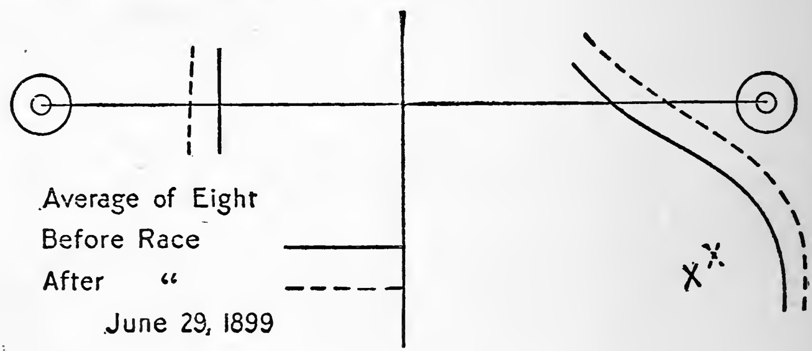


CHART VII.

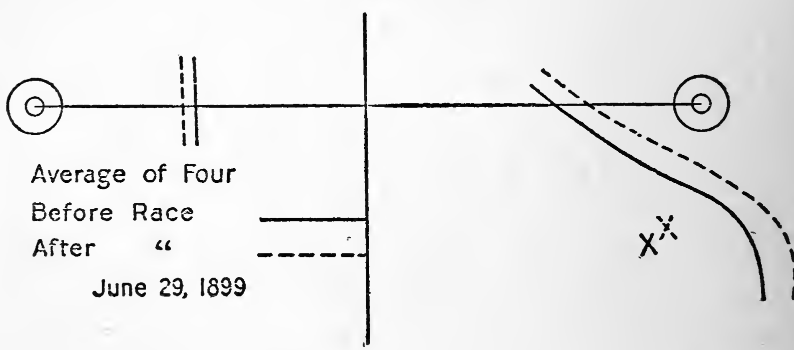


CHART VIII.

During the races, both four-mile and two-mile, a considerable dilatation took place, as shown in Charts VII and VIII. The average increase in breadth of the cardiac dulness was nearly the same in the two crews, — 1.4 centimetres for the eight and 1.5 centimetres for the four. The marked rise of the upper border relative to the inter-mammillary line may be attributed to the fact that the examinations after the race were unavoidably delayed until after dinner, and consequently allowance must be made for the full stomach.

Heart sounds. — The twelve men in the squad may be divided into three groups according to the effect of the training and races on their heart sounds and action.

In Group I, numbering five men, may be placed those whose hearts developed no markedly abnormal condition. The pulse rate at rest varied from 60 to 80, and after the time-rows and races, rose to 120 or thereabouts. The sounds remained normal, except that the first sound became somewhat louder and rougher than normal. Both the first and second sounds were occasionally reduplicated.

In Group II, including two men, the routine examination showed nothing abnormal, but after the time-rows and race both developed a faint blowing systolic murmur, loudest at the left margin

of the sternum in the second and third intercostal spaces, but also audible at the apex. As in Group I, there was some tendency to reduplication of the sounds, but the rhythm remained normal.

In Group III may be placed the remaining five men, whose hearts showed abnormalities of sound or action at several different examinations, both before and after unusual effort. The most extreme case deserves a detailed description. This man had had rheumatism and typhoid, and had been informed several years before that his heart was weak.

Following are the notes as taken:

May 10. Pulse 96; irregular. Diffuse precordial and epigastric pulsation; pulmonic second sound accentuated; blowing systolic murmur audible over entire cardiac area, loudest in pulmonic area and at apex.

May 18. Pulse 84; irregular; heart sounds as above, but murmur inaudible at apex.

May 25, after time-row of 3⅜ miles. Pulse 138; very irregular; two sounds of equal intensity at apex; rhythm embryonic; murmurs very loud over entire precordia.

May 30, before time-row. Pulse 84, somewhat irregular; murmur faint. After time-row of 3⅜ miles. Pulse, 128; fairly regular; murmur much fainter than after previous time-row.

June 7. Pulse 88; sounds as before time-row of May 30.

June 17. Pulse 78; regular; murmur very faint.

June 21. Pulse 82; regular; no murmur. Two hours and a half after four-mile time-row. Pulse 98; regular; no murmur.

June 29, before race. Pulse 84; regular; no murmur. Three hours after race. Pulse 88; murmur audible, but very faint. General condition excellent.

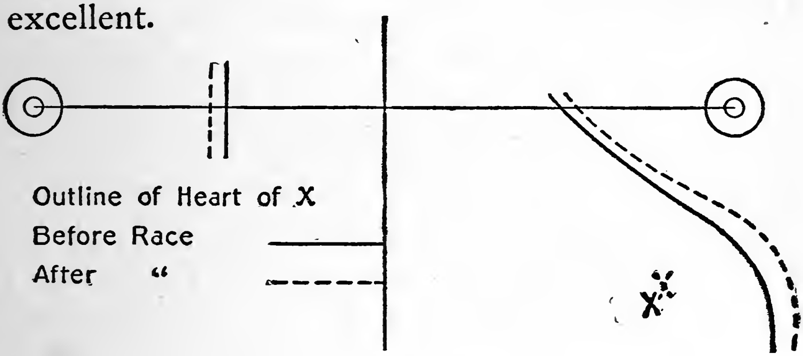


CHART IX.

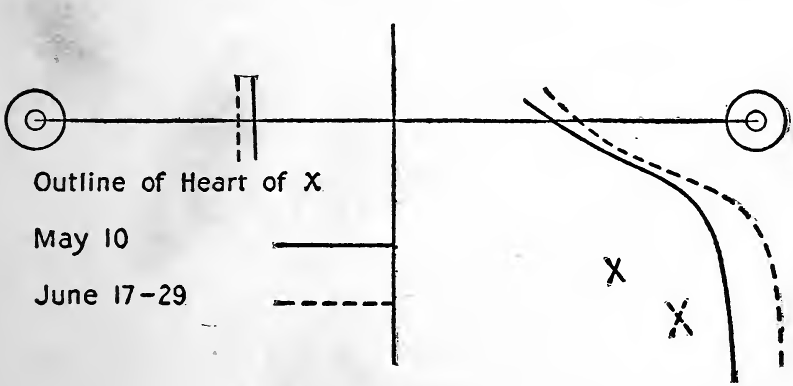


CHART X.

The changes in the size of this heart corresponding to the changes in sounds and action are shown in Chart X, while the comparatively slight increase during the race itself is brought out in Chart IX.

The gradual improvement in this heart was one of the most instructive points in the entire investigation. After the time-row of May 25th it was in bad shape. The irregularity, accentuated pulmonic second sound, embryonic rhythm, and rapid action, together with the enlargement, which was well marked, all pointed to an acute dilatation. During June the establishment of a compensatory hypertrophy was indicated by the return to normal rhythm and rate, the practical disappearance of the murmur, and the stationary size. With all the disturbance shown by examination of this man's heart, there was nothing in his appearance or capacity for work which would have called attention to his heart. If he had been advised to stop rowing when his heart was first examined the best demonstration of the beneficial effects of training would have been missed and the crew would have lost a very valuable man.

The four other hearts in this group showed much the same conditions, though in a less degree. All finished the race in good condition and without any more exhaustion than their companions.

Pulse. — The character and rate of the pulse

have already been mentioned in several instances, and it is only necessary to add that it was invariably of high tension after unusual effort. This was no confirmation of Williams' and Arnold's observation of diminished tension in the Marathon runners. It is possible that the exhaustion of the latter was extreme, and their hearts may have been much more affected than was the case with the crews. It is to be regretted that circumstances forbade the taking of sphygmographic tracings.

The cause of the murmur in acutely dilated hearts is ably discussed by Williams and Arnold; no evidence was secured in this study opposed to their conclusion that the bruits are of mitral origin and are due partly to a relaxation of the circular muscular fibres surrounding the orifice and partly to fatigue of the papillary muscles which control the movements of the valve-cusps.

The chief deduction to be made from this study of the hearts is that the heart is a muscular organ, and that it shows with the other muscles both the fatigue due to violent and prolonged exertion and also the increase in size and power due to proper exercise and nutrition. The fatigue results in dilatation, the increased power in hypertrophy, and one of the main objects of training is the establishment of this hypertrophy. The physiological capabilities of the heart are enormous, and in

judging of the effect of any undue exertion on it we must not regard the murmurs and irregularity alone, but must also consider carefully the way in which the heart is doing its work, its strength, as shown by its ability to maintain a proper arterial tension, and its recuperative power. As with other muscles, not size but quality tells in the long run.

Kidneys. — Periodic examinations of the urine were made coincidently with the heart examination. An attempt was made to estimate the twenty-four-hour amount, specific gravity, urea percentage, and total urea, to test for albumin and sugar, and to examine the sediment microscopically. The figures given below, as far as they refer to the twenty-four-hour amount and calculations based thereon, are probably considerably less than they should be. Even with the best intentions, slips of memory were liable to occur, and the full amount of urine passed was not always saved. Perhaps ten to twenty per cent should be added to the urea excretion for this reason.

The urea was estimated by Squibb's ureometer. For albumin both the nitric-acid and heat tests were employed, and in case of doubt the picric-acid test was resorted to. When an appreciable amount was found, Esbach's albuminometer tube was used. The sugar test used was Fehling's.

TABLE VII. AVERAGE URINE TESTS.

Date.	No. examined.	24-hour amount.	Specific gravity.	Urea, per cent.	Total urea.
		c.c.			gms.
May 9–17	11	1181	1.028	3.42	39.5
May 18–26	11	1396	1.027	2.68	36.9
June 2–8	12	1028	1.027	2.76	27.3
June 18	12	1403	1.022	2.53	34.2
June 20	12	1374	1.024	2.66	36.3

The main facts ascertained are summarized in Table VII, subject to correction, as noted above. These figures denote a moderate increase in the urea secretion above the normal, and by implication a moderate increase in nitrogenous metabolism, but by no means as great an increase as one would expect if all the proteids eaten were absorbed and utilized. Physiologists have proved that an increase in the urea elimination above normal limits is usually caused by an increase in proteid digestion, and not by an increase of muscular action.

Sugar.— The tests for glucose were invariably negative.

Albumin.— An unexpected fact brought out in the routine examination was the presence of traces

of albumin in the urine of a large proportion of the squad under ordinary conditions of training. The twenty-four-hour amounts were examined six times, the tests being made intentionally only after a lapse of several days after the time-rows, to eliminate their effects as far as possible. In eighty-three specimens examined albuminuria was present forty-eight times. The amount of albumin was never more than a trace.

Sediment.— The albuminuria was, with but few exceptions, always accompanied by renal casts and epithelium, and occasionally by a considerable excess of leucocytes. In several instances a few casts were found in urines which gave negative albumin tests. In the few cases of albuminuria without casts, partial decomposition had taken place before the microscopic examination, so that casts may have been present but obscured.

Albuminuria after time-rows and races.— After three of the time-rows, and after both races, the first urine passed was examined for albumin and casts. The specimens were all small in quantity, — one to three ounces,— highly concentrated, and invariably contained considerable amounts of albumin, as shown in Table VIII. The largest percentage observed (0.9 per cent, Esbach) was in the urine of one of the four-oared crew, after the two-mile race. The sediments contained correspond-

TABLE VIII. Albuminuria after Time-rows and Races. Figures Represent Percentages by Esbach's Albuminometer.

Date.	Occasion.	Varsity Eight.							
		1	2	3	4	5	6	7	8
May 25	Time-row	Trace	. . . .	0.12½	0.12½	0.12½	0.12½	Trace	0.25
May 30	Time-row	0.08	. . . .	0.38	0.05	0.12½	0.10	0.05	0.15
June 21	Time-row	Trace	Trace	0.25	Trace	0.05	0.07½	0.07½	0.07½
June 29	Races	. . . .	0.07½	0.25	0.10	0.05	Trace	0.20	0.05

Date.	Occasion.	Varsity Four.				Substitutes.				
		9	10	11	12	13	14	15	16	17
May 25	Time-row	0.25	0.25	0.12½	0.25	0.12½	. . .	Trace	0.12½	Trace
May 30	Time-row	0.05	0.15	0.05	0.05	0.05	0.10	Trace	0.05	0.05
June 21	Time-row	. . .	. . .	. . . .	. . . .	. . . .	. . .	. . . .	. . . .	. . .
June 29	Races	0.90	0.15	0.10	0.07½	. . . .	. . .	. . . .	. . . .	. . .

ingly large numbers of hyaline and finely granular casts, many having renal cells, and red blood corpuscles adherent. In many of the sediments there was also a considerable number of red blood corpuscles and an excess of leucocytes. The sediment in many cases was exactly that of the first stage of acute nephritis, and, if examined without a knowledge of the conditions, might easily have caused anxiety.

To find out how long the albuminuria and casts continued, after the time-row of May 30th, single specimens were examined the following day, before the afternoon row, with the result that of fourteen samples, two contained a trace, and one had 0.025 per cent. It is regretted that tests were not made after the rowing on ordinary days, since it is probable that even this may have caused an appreciable albuminuria, and that the traces found in the twenty-four-hour specimens really represented a considerable amount of albumin passed in one urination after rowing, diluted with non-albuminous urine passed during the rest of the day.

The renal conditions may be interpreted as an active hyperæmia, becoming intense during the time-rows and races, and dependent in all probability on the increased arterial tension. Whether the hyperæmia ever leads to permanent changes in the kidneys is a matter for future investigation.

The blood.— Numerous estimates of the specific gravity of the blood were made by Hammerschlag's method, with the intention of making blood counts and hemoglobin tests should any variation from the normal be observed. The method, however, was found to be tedious and unreliable, the results varying according to the temperature. In several instances, when the specific gravity was low, — 1.050, or thereabouts, — a blood count and hemoglobin test gave normal figures. The examinations made yielded no information of importance and were therefore discontinued.

The digestive system.— One of the most troublesome features in training of all kinds is the care of the digestive organs. Many a race has been lost because of weak stomachs, and because of prostration due to diarrhea. The crew squad this year offered no exception to this common tendency, for there were several cases of temporary attacks of indigestion and diarrhea. These troubles ought not to be attributed to the training, but to improper diet and methods of eating. The food provided was all that could be desired in quality and in preparation. The chief criticisms suggested were in regard to the selection of food by the men themselves, and to their common habit of eating too much and too fast, — faults not confined to crewmen, but nevertheless unwise. The one aim of

many of the men seemed to be to consume as much meat as they could get, and in the shortest possible time. The amount of roast beef devoured at a single meal was astonishing, a man often disposing of five or six large slices.

It has already been pointed out, in discussing variations in weight, that the energy set free in muscular exercise is derived largely from the combustion of fat and carbohydrate material, while the proteid metabolism is directed chiefly to repairing waste. To use a rough illustration, if we regard the body as a machine, the proteid elements of the food go largely to replace the wear and tear of the machine itself, while the carbohydrates and fats furnish the fuel whose combustion liberates heat and energy, and thus enables the machine to do its work. Of course the body is not a machine, and this comparison is not true, except in a general way. During training, the wear and tear of the body, generally, is much increased, and the proteid elements of the food must be increased accordingly; but it is an error to increase them so enormously, as is frequently the case. The slight increase in the urea excretion indicates that most of the proteid material must pass through the digestive tract unassimilated. This throws a great deal of extra work upon the digestive organs, — work which does no good to the body,

but may, and undoubtedly often does, do harm in causing indigestion and diarrhea.

The subject is deserving of study based on analyses of the food and of the excretions. A more accurate adjustment of food to needs and more time spent in mastication would unquestionably prevent that sensitiveness of the digestive organs which is one of the bugbears of the trainer.

III. OVER-TRAINING

It was hoped that during this investigation data might be obtained bearing on the subject of over-training, but unfortunately (or fortunately, according to the point of view) there were no typical cases to study. The common symptoms are well known. They are, in brief, a loss of strength and endurance, so that a man previously strong becomes incapable of prolonged effort. This may be accompanied by a general nervous restlessness, by listlessness, by a loss of weight, by insomnia, and by various digestive disturbances, such as anorexia and diarrhea. These symptoms should not be confounded with the temporary collapse which is occasionally seen after a severe exertion and which is more apt to be due to under-training than to over-training. The real condition at the bottom of over-training is still obscure, but in the light of this inquiry certain

possibilities are suggested as factors which may have to do with its causation.

The first and most obvious one is the condition of the heart. We have seen that a great increase in size and strength is demanded of this organ, and it may easily happen that it is called upon for more work than it is able to do, and that instead of establishing a compensatory hypertrophy it becomes dilated and weakened. A "broken-winded" athlete is probably one with a dilated, flabby heart.

The second possible factor is the condition of nutrition. This is more difficult of demonstration than the first. As already pointed out, the nutrition may be disturbed in two ways, — either by an improper diet, in which the nutritive elements are not apportioned to the needs of the body, or by disturbed digestion, as a result of which the food taken into the body is not utilized. That both of these contingencies may occur has been sufficiently demonstrated.

The third factor may be simple overwork. This is not so likely as the two preceding, for when properly nourished, the capacity for work on the part of healthy young men is certainly much greater than that demanded in training. The peculiarity of training work, however, is its concentration. It may be that the excessive work accomplished in a brief space of time exhausts

the muscles so that they do not recuperate before being called upon for a repetition of the work — that there is, so to speak, an accumulation of fatigue, and that this constitutes over-training.

The fourth factor which suggests itself is a nervous one, and this, while more intangible than the others, is unquestionably an important one. In the present state of our knowledge it can only be surmised, not proved. It is well known that there is a nervous fatigue entirely distinct from muscular fatigue, and resulting from prolonged anxiety, from monotony of work and from numerous other causes. It may be that anxiety about a coming contest, together with the prolonged mental strain of mastering the technicalities of such a difficult art as rowing or such a complicated game as football, may lead to a condition of nervous exhaustion, and that this nervous exhaustion contributes to over-training.

No one of these factors will account for all cases of over-training, and probably more than one cause must be admitted. At any rate, it is safe to suggest certain points which should be borne in mind in laying out any course of training. They are: (1) not to throw too much work upon the muscles, and especially upon the heart, until they are strengthened by preliminary work; (2) to watch the nutrition carefully; and (3) to avoid nervous

fatigue by providing a certain variety of exercise, and by not confining the attention too closely to the approaching contest.

Finally, this investigation has demonstrated that the physiological effects of training, on the heart and kidneys in particular, may approach unpleasantly near to pathological conditions, and that there should be some competent supervision to insure that the safe limits, when those are determined, shall not be passed.

FOOTBALL AND ROWING COMPARED

SINCE the summer of 1899 the investigation into the effects of training, instigated by the Harvard Athletic Committee, has been carried on in several directions. In the first place, during the autumn of 1899 an attempt was made to conduct a series of observations on the Harvard football squad similar to those carried on with the crews and reported in a previous article. In the second place, a number of examinations were made during the year of the crew men who were under observation in the spring of 1899, to determine whether the abnormal conditions developed during that period of training were permanent. Finally, during the 1900 rowing season a further study was made of the university and freshmen crews, largely for the purpose of corroborating the results obtained in 1899. Furthermore, the assistance of Prof. W. O. Atwater and Dr. F. J. Benedict, of Middletown, Conn., was obtained, by whom an exhaustive dietary and digestive experiment was conducted, the results of which are given in

a separate paper.[1] Following is a brief summary of the results obtained along the various line of study.

I. FOOTBALL TRAINING

Although a large number of examinations were made, the results as a whole were not satisfactory. It was not possible to follow the individual players with any degree of completeness, owing to the irregularity of their work and the many interruptions due to injuries. The constant excitement attending the practice and games, and the noisy conditions under which the examinations had to be made, were not conducive to accurate observations. A detailed account of the observations would be largely a repetition of those previously reported, so it will suffice merely to point out the more salient features. The routine examinations were made just before the afternoon practice, so as to eliminate as far as possible the immediate effects of the playing and to get the hearts at the supposedly most quiet period. Seventeen selected members of the squad were examined one or more times, chief attention being paid to the hearts and kidneys. It was not practicable to make extended observations on the fluctuations of weight, temperature, etc.

[1] The summary of this article will be found on page 163.

Hearts. — Of the seventeen men examined, fourteen showed no marked disturbance of the heart's action, although in all the heart was somewhat larger than normal, and in several instances there appeared to be a noticeable reduction in its size as the season progressed. Several hearts showed some irregularity in rhythm, but without abnormal sounds; and in several the first sound was somewhat harsher than the normal at the apex, but not sufficiently changed to be considered a murmur. In three hearts the changes were marked enough to warrant more detailed description. The most pronounced disturbance was in the case of a man who had been an athlete for several years and had had no history of heart trouble. His general condition was excellent throughout the period of training, though once disabled by injury. On October 4th, after about two weeks of hard playing, his pulse was 72 and somewhat irregular. The apex beat was in the mammillary line and there was distinct epigastric pulsation. On auscultation a loud systolic murmur could be heard at the apex. This was propagated into the axilla and was audible, though less distinct in the second, third, and fourth intercostal spaces at the left border of the sternum. On October 27th the pulse was 57 and regular. The murmur was still distinct at the apex, but was not conducted. This improvement was thought

to be due to an enforced rest of two weeks, following an injury. On November 17th, just before the Yale game, the murmur could be heard clearly at the apex and very faintly at the left sternal border. In February, 1900, three months after stopping training, the pulse was 76, regular and normal. The apex beat was about an inch inside the nipple line, and there was no abnormal pulsation. The cardiac rhythm was normal, but a faint systolic murmur was still audible at the apex.

The abnormal signs in this case were so marked and persistent that it seems probable that there was a slight organic lesion of the mitral valve. The condition was not unlike that of one of the crew in 1899, previously reported, and as in that instance, while the hard work of the first part of the training season disturbed the heart's action to a marked degree, there was a steady improvement as the season advanced. It is not to be denied that there is a risk in allowing men with such hearts to take part in contests involving such prolonged and violent efforts as football and rowing, but in the light of these cases it is difficult to predict just what the result in any given instance is likely to be.

In the other two cases of well-marked cardiac disturbance the trouble was of a temporary nature. In one the first sound was always harsh and the

action somewhat unsteady, but no murmur appeared until just before the Yale game, when a well-marked murmur was audible at the apex and left sternal border. In the third case the disturbance was marked only at the first examination. This man joined the squad late, and was examined after but two days of hard practice. The chief abnormal sign, beyond enlargement of the cardiac dulness, was a loud blowing systolic murmur at the left border of the sternum. At subsequent examinations this gradually became fainter, and after four weeks it disappeared entirely.

The condition of the heart immediately after playing a hard game was studied in a number of instances. The effects as a rule were like those observed after hard rowing; that is, an increase in the area of dulness, increased pulse rate up to 150 or even more, a roughening of the first sound at the apex, and very often a faint blowing systolic murmur heard most distinctly in the pulmonic area. In vigorous hearts these signs were of brief duration, and were interpreted as indicating merely a passing dilatation. The examinations were all made with the man first standing erect and then with him lying supine. In several instances, but not in all, lying down caused an immediate drop in the pulse rate. In one case, standing, it was 144; lying, it at once fell to 64;

standing a second time it rose to 112, and again lying it fell to 68. The normal rate for this man was about 68, and his heart never showed any other disturbance. In a second case the pulse rate fell from 120 to 72 on lying down, and in a third case from 108 to 72. Other cases showed no marked effects from changes of position.

Kidneys. — The urine of sixteen members of the squad was examined one or more times during the training season. In each instance the full twenty-four hour amount was collected and measured, and the specific gravity, percentage of urea, and total urea were determined. The specimen was then tested for albumin and the sediment examined microscopically. The average daily renal excretion was 1124 c.c., specific gravity 1.027, urea percentage 3.30, and total urea elimination 36.2 gms. In six cases out of sixteen albumin was present in small amount at one or more examinations and was always accompanied by hyalin and granular casts, an excess of leucocytes, and occasionally by red blood corpuscles.

A number of additional examinations were made of urine passed immediately after hard playing, and in every instance considerable amounts of albumin were found (from $1/20\%$ to $1/10\%$ Esbach), together with many casts, and usually red blood corpuscles.

II. COMPARISON OF EFFECTS OF ROWING AND FOOTBALL

On the whole, the effects of football training are not markedly different from those of rowing, though the departures from the normal are not so great. This is readily explained by the intermittent nature of the effort in football. The game consists of a series of exertions, each one exhausting but brief. The intervals of rest occupy a large portion of the time of play. This is in marked contrast to rowing, in which the periods of effort are far more prolonged, and the exertion, while less violent, is continuous. In both sports the effects of training appear to be to accustom the heart, kidneys, and other organs to the extraordinary demands, so that as the season progresses they do their work more easily.

III. FURTHER OBSERVATIONS ON THE EFFECT OF ROWING

During the 1900 rowing season a second series of examinations was undertaken, similar to that of the preceding year, with the object of verifying the facts then ascertained. The general effects on the weight, temperature, heart, kidneys, etc., were in all important points the same, and need not be described again at this time. Two events, how-

ever, occurring at the very end of the training season, were of great interest from the physiological point of view. One was the effect on the crew, as a whole, of the accident which deprived it of its stroke and captain four days before the race, and the other was the collapse of the substitute stroke during the race. On the Sunday preceding the Thursday of the race the captain twisted his right ankle, fracturing the lower end of the fibula. Up to this time the men, with a single possible exception, had been in excellent physical condition. There had been less than the usual disturbance of digestion and other untoward symptoms, which are so common during the last part of a severe period of training. The accident necessitated the substitution of a new stroke, and a great increase in the amount of rowing above that which had been planned for the remaining days, in order to accustom the men, as far as possible, to the new arrangement. The result was a marked change in the general tone of the men. The calmness and quiet determination which had characterized them hitherto was replaced by a nervousness and restlessness, and they attacked their work with a kind of desperation. Coincidently, there was a temporary falling-off in the appetites, and, in most cases, some loss of sleep. The effect on the weights was striking. The men were not weighed on Sunday,

the 24th, so comparison must be made with the Saturday weighings. For purposes of comparison let us take only the afternoon weights of the seven men who were in the boat during all of the last fortnight. On June 14th, when the crew arrived at New London, the average weight of the seven was 171.9 pounds. During the following week it fell to 169.6 pounds. It then rose once more and reached the former mark on June 23d, the day before the accident. After this it fell, on the average over four pounds per man, reaching 167.2 pounds, just before the race. Allowance must be made for the loss of weight which always occurs before a contest. During the corresponding period in 1899 the average loss was a little over two pounds per man, most of this coming during the last twenty-four hours.

The excessive loss of weight may be attributed partly to indigestion, partly to insomnia, and partly to the increased work done. However, the condition of the men on the whole, just before the race, was thought to be fairly good, though not as good as it had been a week earlier. With the exception of the substitute stroke, all finished the race in fair condition. One man, who was apparently all right at the finish, fainted about fifteen minutes after boarding the launch, but this was probably due largely to the fact that he lay down in the stern

near the engine, where the air was close and hot. He revived after a short time, and showed no lasting ill effects.

The case of the substitute stroke deserves more detailed description. The sudden responsibility thrown upon his shoulders, and the unavoidable hard work during the last three days before the race, had unquestionably affected him more seriously than any one else. He had lost about 5½ pounds and had been troubled a great deal with insomnia and indigestion. After rowing an exceedingly effective race for three miles, he suddenly collapsed, and, during the last mile, was practically helpless and unconscious. After the race he remained in a semiconscious state for about an hour. He could be partially aroused with some difficulty, but wished to be let alone. He was then perspiring freely. His pulse was about 120, and rather weak, and respiration was rapid and sighing. The din of whistles and guns forbade a careful examination of the heart, but a superficial examination revealed nothing but a rapid, weak action. The temperature could not be accurately determined until an hour after the race, when it was 100.4° in the axilla. It was probably considerably higher than this at first, as meantime he had been repeatedly douched with cold water and had perspired freely. After reaching the

quarters he swallowed a cup of hot bouillon, but immediately vomited it. During the afternoon he remained quiet and comfortable, but complained of great drowsiness. In the evening he was able to retain some toast with hot water.

He passed from under the writer's observation at that time; but in a letter written four weeks later he stated that, while he recovered from the immediate effects within two or three days, he had not yet entirely regained his former vigor. The symptoms described were those of collapse due to over-exertion when not in perfect condition, and in all probability greatly intensified by the heat. He said afterward that he remembered feeling unusually hot before the race. He had already had an attack of heat prostration several years before, which may have predisposed him to this. The occurrence was a very unfortunate one, but it is only fair to regard it as accidental, because resulting from a combination of circumstances which could not have been foreseen.

IV. AFTER-EFFECTS OF TRAINING

Between June, 1899, and the spring of 1900, examinations were made as occasion arose of the men comprising the rowing squad of 1899, to determine, as far as possible, the after-effects of training, and particularly to study the duration

of the cardiac and renal disturbances. Eight of the twelve men comprising the squad were examined and the results were practically uniform. As pointed out in another place, the heart during a period of training takes on a considerable degree of hypertrophy, while the immediate effect of a severe effort like a race is an acute dilatation. The later condition is a temporary one, and seems to become less marked with each succeeding effort if the training is successful; that is, if the man remains in good condition. The hypertrophy, on the contrary, appears to be a more or less permanent change. In the case of the racing men it is to be remembered that they did not lapse into complete idleness after breaking training, but all kept up some kind of active exercise during the summer and autumn. This would of course to a certain extent prevent the return of the hearts to normal size.

It must not be supposed, however, that hypertrophy of the cardiac muscle from training is to be regarded as an undesirable thing any more than a corresponding hypertrophy of the biceps. It is conceivable that too frequent repetition of severe efforts might result in a permanent dilatation and loss of tone instead of in a true hypertrophy; but in these eight men there was no evidence that this had occurred. In every instance, save one, the

pulse had a normal rate and rhythm, the heart sounds were normal, and no adventitious sounds could be detected; in fact, the only abnormal signs to be made out were an increase in the distance of the apex beat from the median line and a corresponding enlargement in the area of cardiac dulness. These measurements differed but little from the corresponding measurements made in June just before the race.

The only exception was in the case of the man whose heart was profoundly disturbed during the period of training, as described in detail in a earlier paper. In March, 1900, nearly nine months after stopping training, examination of this man showed an irregular pulse rhythm. There was still a murmur, audible faintly but clearly at the apex and at the left sternal border. In this case, as pointed out before, there was probably an organic valvular lesion dating back to an early illness and not attributable to training.

Examination of the urine of these eight men showed in most cases an early disappearance of the albumin and casts. One man, examined July 17th and August 10th, still presented a trace of albumin but no casts. Further tests were impossible in this case, so the duration of the albuminuria is not known.

Beyond the cardiac and renal conditions the men

presented little of importance. Several stated that they had suffered from indigestion shortly after stopping training, due probably to the fact that they unconsciously continued the habit of eating large amounts of food after they had ceased to need it. Otherwise they all claimed to be in perfect health, and their appearance did not belie their words. There was an increase in weight of from three to twenty pounds, not so much during the summer as during the following winter; but this may have been simply natural increase in fat commonly seen in cold weather.

In summary, it may be said that no ill effects, which could reasonably be attributed to training, were to be discovered nine months after stopping the training.

DIETARY AND DIGESTION EXPERIMENT

SUMMARY

In June, 1900, a study was made of the actual amounts and composition of food eaten by four members of the Harvard University crew during one week of active training immediately preceding a race. The data obtained also included the statistics of the quantity and composition of solid and liquid excreta, during the same period. The investigation thus included a dietary study, a digestion experiment, a study of excreta, and a nitrogen metabolism experiment.

Dietary study. — The four men ate on the average 154 grams of protein, 139 grams of fat, 473 grams of carbohydrates with a fuel value of 3925 calories per man per day. The results compare with the results of other studies as follows:

	Protein.	Energy.
	Grams.	Calories.
Four members of Harvard University crew, New London, 1900	154	3925
Harvard University crew, New London, 1898	160	3945
Average Harvard and Yale University and Freshmen crews, Cambridge, New Haven, and New London, 1898	155	3955
Average 38 dietaries of men at ordinary occupations in the United States	102	3310

It thus appears that the four men ate just about as much as the Harvard and Yale crews in 1898, and that their food

had about 50% more protein and 16% more energy than that of the men at ordinary occupations in the United States whose dietaries have been studied.

Digestion experiments. — Comparison of the amounts of nutrients in the food with those in the solid excreta shows the amounts which were actually available. These were nearly, but not quite, the same as the amounts actually digested. They differ from the latter by the amounts of metabolic products in the feces. The average coefficients of availability in these digestion experiments were:

Protein	92.2
Fat	95.6
Carbohydrates	98.1%
Energy	91.8%

These figures are very nearly identical with those obtained by taking the coefficients of availability of food as found by experiments with men on ordinary diet and at ordinary occupations and applying them to the diet of the men in the present experiment. This means that the four athletes, on the average, digested their food just about as completely as the average man does. There were, however, marked differences in their capacities to digest their food.

Studies of the excreta. — No special studies were made of the composition of the feces. Comparisons of the urea and uric acid in the urine failed to bring any results such as to warrant conclusions regarding the effect of severe muscular exercise on their amounts.

Nitrogen balance. — One notable feature of the experiments was found in the fact that the nitrogen excreted by the kidneys and intestines was considerably less in amount than the total nitrogen of the food. This means that there was a considerable storage of nitrogen in the body. The amount was such as to correspond to an average of not far

from 24 grams of protein per day if no allowance be made for the excretion of nitrogenous compounds in perspiration through the skin. Even after making allowance for a very considerable excretion of nitrogen through the skin, this gain is so noticeable as to suggest the queries whether men who are storing nitrogen to such an extent are in the best physical condition, and whether the amount of protein in the diet was the most appropriate for the purpose.

Need for further research. — Perhaps the most important conclusion to be derived from the experiments is that further and more detailed investigations are needed to show what diet is best for men under such severe muscular strain as that of oarsmen in training for races.

A Study of the Food consumed and digested by Four Members of the Harvard University Boat Crew in June, 1900, by W. O. Atwater and F. G. Benedict. Reprinted by permission of the Boston Medical and Surgical Journal from Vol. CLXIV, 26, pp. 601–629.

INDEX